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REPORT RESUMES

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THE EVALUATION AND DEVELOPMENT OF TECHNIQUES FOR TESTING THE VISUAL AND AUDITORY ACUITY OF TRAINABLE MENTALLY RETARDED CHILDREN.

BY- WOLFE, WILLIAM G. AND OTHERS
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AUDIOMETRIC AND VISUAL PROCEDURES WERE COMPARED ANALYTICALLY AND/OR DESIGNED TO ESTABLISH TEST METHODS FOR TRAINABLE MENTAL RETARDATES IN THE IQ RANGE OF 23-47 AND BELOW THE MENTAL AGE OF 4 YEARS. THE NUMBER OF SUBJECTS WAS 26 FOR THE AUDITORY PROGRAM AND 25 FOR THE VISUAL. EACH OF THE SUBJECTS WAS STUDIED ON AN INDIVIDUAL BASIS. DATA WERE COLLECTED ON THEIR VARYING SOCIAL, MENTAL, AND PHYSICAL ABILITIES AND THEN RELATED TO THEIR AUDITORY AND VISUAL ACUITY. THE AUDIOMETRIC TESTS CONSISTED OF PURE-TONE THRESHOLD ACUITY TECHNIQUES, PSYCHOGALVANIC SKIN RESPONSE (PGSR) AUDIOMETRY, MODIFIED SPEECH RECEPTION, AND SCREENING TECHNIQUES. TWO VISUAL TEST BATTERIES WERE EMPLOYED, CONSISTING OF 8 COMMERCIALLY AVAILABLE INSTRUMENTS AND 10 MODIFIED/CONSTRUCTED TESTS PRESENTED TACHISTOSCOPICALLY WITHIN LIMITS OF EXPOSURE TIME OF .01 SECOND TO 1.0 SECOND, INCLUSIVELY. ALL TESTS WERE ADMINISTERED TO EACH CHILD ON A PRETEST, TRAINING, AND POST-TEST BASIS. THE CHILDREN IN THE AUDIOMETRIC STUDY RESPONDED MEANINGFULLY WHEN BOTH SPEECH AND PURE TONES WERE USED AS THE STIMULI. COLOR AND FORM PERCEPTION TESTS WERE CONSIDERED VERY MEANINGFUL IN THE VISUAL REALM. IMPLICATIONS FOR FURTHER STUDY WERE PROVIDED FOR BOTH THE AUDITORY AND VISUAL TEST AREAS. CONCLUSIVE TECHNIQUES ARE NEEDED TO DETECT AND REMEDY PHYSICAL DEFECTS OF THE TRAINABLE RETARDATE. (JH)

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THE EVALUATION AND DEVELOPMENT OF TECHNIQUES FOR TESTING THE AUDITORY ACUITY OF TRAINABLE MENTALLY RETARDED CHILDREN

Project Director: William G. Wolfe, Ph. D.
Research Associate: James R. MacPherson, Ph. D.

THE UNIVERSITY OF TEXAS
November, 1959

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FOREWORD

This study is Part I of a two-part investigation authorized as Project Number 172 (6447), Cooperative Research Program, United States Department of Health, Education and Welfare, Office of Education. The title of the major project is as follows:

> "Comparative Investigation of Methods of Testing Auditory and Visual Acuity of Trainable Mentally Retarded Children"

This portion of the major project was completed in August, 1959, in the Department of Educational Psychology, College of Education, The University of Texas, Austin, Texas, by Dr. James R. MacPherson, Research Associate and was directed by Dr. William G. Wolfe, Professor of Educational Psychology.

ACKNOWLEDGEMENTS

Many people made important contributions to this research. Special thanks should be extended to Dr. Oliver H. Bown, Dr. Lennert L. Kopra, Dr. John R. Peck, Dr. Robert F. Peck and Dr. George I. Sanchez, for their guidance and professional advice during the two years this research was being conducted. Also, without the help of Mr. Jasper Harvey, Mr. Jack Mills and Mr. Joe Granthan, Research Associates and Assistants on the major project, this study would not have been completed.

It would not have been possible to complete this study without the excellent cooperation of the members of the staff of the Austin State School, the Wooldridge Elementary School, and the Austin Opportunity Center for Retarded Children. Both the teachers and the administrators were very generous in allowing the children to be taken from classes for audiometric testing.

Special mention should be made of the fine cooperation extended this project by Mr. C. Merle Brooks, Manager, AMBCO, Inc., of Los Angeles. Mr. Brooks provided an Ambco Otometer, Model 600-D, for use in designing a portable test of auditory acuity of these children.

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CHAPTER I

THE PROBLEM AND DEFINITION OF TERMS

The Problem

Statement of the problem. It was the purpose of this study to evaluate audiometric techniques for use in testing the auditory acuity of trainable mentally retarded children. Some of the audiometric techniques which were used in the study were structured especially for this study.

Importance of the study. The auditory acuity of the mentally retarded had been investigated in a few studies, but no study had been attempted with a group consisting only of trainable mentally retarded children. Most of these studies that had been done had as their sole purpose the determination of the incidence of hearing loss among the mentally retarded, and not the purpose of considering which audiometric techniques could be used best with the trainable mentally retarded.

The diagnosis of auditory impairment in any child is very important. When the child is mentally retarded, this diagnosis is very difficult. Audiometric techniques which could differentiate between the hearing loss presented by the mentally retarded child and the hearing loss presented by the hard of hearing child needed to be improved. Sheridan (55) stated that the deaf child is organically unaware of sounds, but that the mentally retarded child may be functionally unaware of them. The ability of the mentally retarded child to perceive sound may be as dull as his intellectual processes are slow. The role hearing loss plays in producing behavior which is suggestive of mental retardation has been pointed out by Sheridan (55), Benton (24), and Hardy. Hardy (38) said:

> Clinical experience demonstrates that impaired hearing in a child may produce behavior that is suggestive of feeblemindedness, whereas, when the facts of hearing loss are known and are clearly interpreted in terms of language development and psychologic adjustment, the child's "mindedness" proves to be quite within normal range. Because of the close relation between hearing and the development of language--and between hearing and a wide range of general developmental behavior--the child with impaired hearing may be linguistically and socially retarded, but his is only a pseudo-feeblemindedness and may be corrected when the hearing impairment is recognized and compensated for by suitable therapy and special training. The source of the difficulty, often confounded by a lack of native mental endowment, is a specific physical disability. (p. 432)

Benton (24) considered the role which hearing loss and other sensory deprivations play in the concept of pseudo-feeblemindedness. Benton divided the concept of pseudo-feeblemindedness into two parts. In one part, he said that pseudo-feeblemindedness is nothing more than a mistake in diagnosis; the child is considered feebleminded and when this proves not to be the case, the term "pseudo-feeblemindedness" is used to describe the child. He said that this is a mistake and that in this sense of the word, there should not be any such clinical classification as pseudo-feeblemindedness. In the other part of Benton's division of the concept, pseudo-feeblemindedness presents a picture of behavioral retardation which is almost the same as that associated with true mental deficiency, but which is determined by factors other than defects or diseases of critical cerebral areas which are the causes of true mental deficiency. Benton made the distinction between true feeblemindedness and pseudo-feeblemindedness on the nature of the responsible etiologic factors. He said that pseudo-feeblemindedness represents mental deficiency of an atypical etiology. One of the types of atypical etiologies which he pointed out which can cause pseudo-feeblemindedness is sensory deprivations, such as auditory impairment. The defective intellectual state which can result is not false, but it is a true mental defect from a behavioral standpoint and differs from a true mental deficiency only in respect to etiology. This condition can be permanent and continue throughout life unless the true condition is discovered and appropriate corrective action is taken whenever possible.

Kodman, et al. (49), conducted a study on the use of pure-tone audiometry with mentally retarded children. The only technique which they used in their study was the ear-choice technique. They expressed the opinion that it was doubtful that with the procedures used in hearing surveys with the mentally retarded that actual thresholds are obtained as often as desired. As a result of their study, they recommended that a formal investigation be done to determine the reliability and validity of pure-tone audiometry with the mentally retarded, and that the over-all findings be verified by a test-retest, by speech audiometry, the peek-show technique, and psychogalvanic skin response audiometry, or by a combination of these techniques.

Myklebust (9) pointed out the lack of studies on the sensory capacities of the mentally deficient. He also pointed out that what might be presumed to be sensory defect is nothing more than a deficiency of perception. Since the higher brain centers of the child are deficient, the child's ability to understand sensations is greatly reduced.

Techniques are needed which will aid in the audiometric evaluation of the mentally retarded child or the child who is suspected of being mentally retarded. These techniques must contain sufficient interest to keep the child responding at near threshold levels of intensity. The present study represented an attempt to structure and evaluate such techniques.

Sample population. The sample population used in this study consisted of 26 trainable mentally retarded children. Ten of the children were from the Austin State School and the other 16 were children residing with their parents in the Austin area. All of these children were in classes for trainable mentally retarded children, and all of the children had been classified as mentally retarded children prior to their participation in this study. Each child was given individual intelligence tests by a clinical psychologist. The results are shown in Appendix C. To supplement the findings of the psychologist, Vineland Social Maturity Scales were administered for each child with either the parents or the cottage supervisor at the Austin State School as the respondent.

The following is the complete list of the baseline data available for each child in the study:

1. Case history (birth and developmental information).
2. Psychological evaluation.
3. A medical work-up including the following:
    a. Pediatric examination.
    b. Neurological examination.
    c. Electroencephalograms (EEG).
    d. Ophthalmological and otological examinations.
    e. Urinalysis.
    f. Blood chemistry.

Some of the baseline data were not pertinent to this study. They were used, however, in other research with the same sample of children. Some data, such as the otological examinations, yielded no positive findings of significance to this study. The pediatric examinations, the neurological examinations, and the EEG's contained positive findings which confirmed the diagnosis of mental retardation in these children.

The chronological ages at the time of the psychological examinations of the sample population ranged from five years, four months to 12 years, three months. The mental ages ranged from one year, eight months to three years, 11 months. The IQ's ranged from 23 to 47.

The 26 children were considered in four different ways. First, all of the children were considered as a total group. Second, the children were in three classes. One class was in a public school, one class was at the Opportunity Center, and the third class was in the Austin State School. Each of these three school groups were considered individually. Third, the neurologist divided the children into four neurological groups on the basis of his neurological examination and the other available medical data. Each of these groups was considered. Fourth, the children were divided into two groups: one group above the mean IQ and the other group below the mean IQ.

The four neurological groups into which the neurologist divided the children were: First, one child was classified as a non-mongoloid with no neurological defect. This group was not considered in the statistical analysis. Second, 14 children were classified as being non-mongoloid with neurological defects. Third, seven children were classified as mongoloids with no neurological defects. Fourth, four children were classified as being mongoloids with neurological defects. A summary of the data used by the neurologist to make the neurological classifications is shown in Appendix D.

Definitions of Terms Used

The definitions of the following terms are necessary for an understanding of this study. Most of these terms are from the areas of audiology and psychology. These terms are defined to make their usage in this study explicit.

Auditory acuity. Warren (16, p. 25) defined auditory acuity as: "the sensitivity of hearing measured by the stimulus--energy which gives an audible sound in 50 per cent of the trials."

Best binaural average (BBA). A publication of the Texas State Department of Health (21) gave the following definition:

> The best reading is taken from the audiogram at 500, 1000, and 2000 cycles per second, without regard for which ear provides this best reading. These three readings are averaged and the result, in decibels, approximates the loss of hearing for speech. (p. 18)

Chronological age (CA). This is the age of the children since birth. In this study, it was expressed in years and months.

Decibel (db). *The American Standard Acoustical Terminology*

(1, p. 10) defined the decibel* as ". . .one-tenth of a bel." The American Standard Acoustical Terminology defined the bel* as ". . .a dimentionless unit for expressing the ratio of two values of power, the number of bels being the logarithm to the base 10 of the power ratio."

Free Field. Fitzhugh (4, p. 25) defined free field as follows: "Instead of sound coming through the headphones on the ears of the recipient, it is projected through a loudspeaker. This method is used either with live voice or recordings."

Frequency. Wood (19, p. 56) gave the following definition: "The number of cycles per second of a wave or other periodic phenomenon."

Hearing loss. Hirsh (6, p. 337) gave the following definition: "The hearing loss of a sound is the difference (in decibles) between the threshold for that sound and the corresponding normal threshold."

Hearing loss for speech. The American Standard Acoustical Terminology (1) defined hearing loss for speech* as follows:

> Hearing loss for speech is the difference in decibels between the speech levels at which the average normal ear and the defective ear, respectively, reach the same intelligibility, often set at 50 per cent. (p. 23)

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*This material is reproduced from the American Standard Acoustical Terminology, Z24.1-1951, copyrighted by ASA, copies of which may be purchased from the American Standards Association at 70 East 45th Street, New York 17, N.Y.

Intelligence quotient (IQ). The ratio between the mental age and the chronological age. The mental age is divided by the chronological age and the quotient is multiplied by 100 to get the IQ.

Mental age (MA). Pillsbury and Pennington (11, p. 342) defined mental age as: "That stage of mental development of a person determined by a comparison of his performances with the average performances for his chronological age."

Psychogalvanic skin response (PGSR). Pillsbury and Pennington (11) gave the following definition:

> Involuntary reaction to stimuli, characterized by decreased skin resistance to the passage of a weak electrical current. The skin reflex is one indirect method by which to measure the stirred-up condition of man during an emotional experience. Often abbreviated as PGR for psychogalvanic reflex. Galvanic refers to the fact that the change in resistance to the passage of an electric current is shown by a galvanometer. (p. 326)

Woodworth and Schlosberg (18) pointed out that psychogalvanic reflex (PGR), galvanic skin response (GSR), and electrodermal response (EDR) are all names for the same phenomenon.

Pure tones. Pure tones were defined by Wood (19, p. 63) as follows: "periodic sound waves of the sinusoidal type which have no partials or overtones."

Screening. Hirsh (6) gave the following definition:

> Audiometric screening is a method or group of methods designed to separate individuals whose thresholds lie

> above the normal from those whose thresholds lie at or below the normal threshold. Both speech and pure tones are used as test signals. (pp. 341-342)

Threshold of hearing. Fitzhugh (4, p. 14) gave the following definition: "It is the recognized minimum intensity of a given tone which is just perceptible to the recipient. . ."

Trainable mentally retarded. A publication of the State of Illinois (20) defined the trainable mentally retarded as:

> . . . those who develop at such a slow rate that they are unable to profit from a program of instruction for the educable mentally handicapped, but they have potentialities for (1) developing the abilities to adjust acceptably to the home and neighborhood, (2) improving their ability to care for themselves in many respects, and (3) contributing to their own economic usefulness in the school, in the home, and in a residential school or in a sheltered environment. (p. 3)

Capobianco (2, p. 237) gave another definition of the trainable mentally retarded: ". . . the severely retarded, often synonymous with 'trainable,' are referred to as mentally deficient and defined according to IQ scores, 25 to 55."

Major Hypotheses of the Study

All of the hypotheses of this study are stated in the form of the null hypothesis. Each of these hypotheses was tested statistically. The purposes of these hypotheses are to test the significance of the differences between the audiometric techniques used in the study and to test the significance of the differences between the thresholds of hearing of the various groups of trainable mentally retarded children used in the study.

1. There are no significant differences between the pretest and post-test thresholds of the pure-tone threshold acuity techniques.

2. There are no significant differences between the pretest and post-test thresholds on the modified speech reception test.

3. There are no significant differences between the thresholds of the three school groups.

4. There are no significant differences between the thresholds of the three neurological groups.

5. There are no significant differences between the thresholds obtained on the three pure-tone threshold acuity techniques (the blinking light, the ear-choice, and the Pediacoumeter).

6. There are no significant differences between the thresholds on the blinking light, the ear-choice, and the Pediacoumeter, and the thresholds obtained on the PGSR threshold acuity technique.

7. There are no significant differences between the average of the thresholds of 500 cps, 1000 cps, and 2000 cps of each ear and the modified speech reception threshold for that ear.

8. There are no significant differences between the free field thresholds of the modified speech reception technique and the best binaural averages of the pure-tone threshold acuity techniques.

9. **The time required to administer an audiometric test is not correlated significantly with the CA, MA, or IQ of the trainable mentally retarded child.**

CHAPTER II

REVIEW OF THE LITERATURE

The literature concerning audiometric techniques to be used in determining the auditory acuity of the mentally retarded was very limited. No studies were located which were research solely on the auditory acuity of trainable mentally retarded children nor on the audiometric techniques used to determine the auditory acuity of these children.

Birch and Matthews (25) conducted a study at the Polk State School and reported that three times as many male mental defectives have a hearing loss as did a comparable sample of males from the general population; also, ten times as many female mental defectives from the Polk State School had a hearing loss as did a comparable sample from the general population. They found that 32.7 per cent of the subjects in their study had a hearing loss that would handicap them in ordinary life. For the 247 cases used by Birch and Matthews, the median IQ was 49, Q_3 was 58, and Q_1 was 42. The chronological ages ranged from 10 to 19 years.

In their study, Birch and Matthews were not concerned with audiometric techniques, but only with the hearing acuity of the mentally retarded. If a subject in their study was incapable of responding to the pure tone either by raising his hand or by a verbal response, he was dismissed and his audiogram was discarded as unreliable.

Johnson and Farrell (45) conducted a study at the Walter E. Fernald State School on the auditory impairments of residential mentally retarded children. Johnson and Farrell found that the incidence of hearing loss was approximately five times the incidence of hearing loss among public school children of a comparable chronological age. They found 64 per cent of the hearing impaired children had bilateral auditory impairments which they considered to be severe social and communication handicaps. The mean IQ of the children with impaired hearing was 60.9. Johnson and Farrell did not report on the audiometric techniques used in this study.

As a result of their study, Johnson and Farrell raised the question as to what procedures should be established to eliminate the possibility of children remaining in mental institutions with unknown or unsuspected hearing losses. The possibility of unsuspected hearing losses raised doubts as to the validity of any mental age estimate which is made on the basis of tests and interviews which last for a short period of time, and which, in many instances, rely heavily on verbal material. Such tests penalize the child with a bilateral hearing loss.

Kodman, et al. (48), conducted a study on hearing loss among mentally retarded children and adults. They divided their sample into two groups. The "Young Group" of 84 subjects ranged in age from seven to 19 years with a mean age of 15.37 years; the average mental age was 6.83 and the average IQ was 53.06. The "Old Group" ranged in age from 20 to 60 years with a mean age of 38.70 years; the average mental age was 6.44 and the average IQ was 47.8. The criterion used to classify a person as having a hearing loss was a loss of 30 decibels. The "Young Group" had a 19.04 per cent incidence of hearing loss. When both groups were combined, 21.43 per cent of the subjects had a hearing loss. Kodman, et al. (48), stated:

> The average hearing loss for the sample, 21.43 per cent. . . indicates that approximately 1 out of 5 had a 30 db or greater loss. Nineteen per cent of the Young Group met the hearing loss criterion. This percentage is almost a four-fold increase over the national estimate for our public school children. It raises the question, however, as to the actual difference in impaired hearing sensitivity between the two populations. (p. 461)

Kodman, et al. (48, 49), used the ear-choice technique in their study. They concluded that it was doubtful that with the procedures used in hearing surveys with the mentally retarded that actual thresholds are obtained as often as desired.

Foale and Paterson (34) conducted a study in the British Isles at Lennox Castle on a group of mentally defective boys with a mean

IQ of 66. They found a higher incidence of hearing loss than was found in the normal population of the British Isles. They found 13 per cent of the boys in Lennox Castle had hearing losses which would handicap them in ordinary life. They did not report the audiometric technique used in their study, as the emphasis in their study was on the hearing loss and not on the audiometric technique.

Schlanger (53) reported on the hearing loss of a group of institutionalized mentally retarded children. There were 74 children in the group between the chronological ages of eight and 16 years. The IQ of these children was 40 or above and the mean mental age was six years, eight months. Schlanger was concerned only with hearing loss for speech. He said:

> The binaural loss of hearing for speech was computed on the basis of the formula recommended by the AMA. This loss subtracted from 100 per cent gave the per cent hearing used in the statistical calculations. An AMA per cent hearing evaluation under 96 per cent but no lower than 90 per cent was defined as a "slight" loss; less than 90 per cent but no lower than 55 per cent, a "moderately severe" loss; an evaluation below 55 per cent was defined as a "severe" loss.
>
> Hearing loss was indicated in approximately 30 per cent of the total group. Fourteen per cent are included in the "moderately severe" and "severe" categories. Both of these percentages exceed Silverman's estimate that about five per cent of the normal school children between the ages of five and seventeen are defective in hearing. (p. 341)

Schlanger did not report on the audiometric technique used in his study. His concern was with hearing loss and its effect on speech and not on the audiometric technique.

Schlanger and Gottsleben (54) reported on the results of pure-tone audiometric tests administered to 498 mentally retarded subjects at The Training School at Vineland, New Jersey. The mean chronological age of the subjects was 28.9 years ± 17.3. The mean mental age was 7.8 years ± 3.0. No information was given by Schlanger and Gottsleben as to the IQ range of the subjects. Test results indicated that 28 per cent of the subjcts had moderate hearing losses, six per cent were hard of hearing, and one per cent deaf.

Schlanger and Gottsleben (54) gave the following description of the audiometric technique used in their study:

> Some modifications from the usual audiometric techniques were instituted. A longer training period usually occurred so that hand signal responses to tone were learned. Intensity levels of 50 db were fed into each ear at three frequencies, 250, 1,000, 3,000 cps, so that the subject knew for what he was listening. In the event that no response was obtained, db levels were raised. This whole training period, brief in some instances, was used as a warm-up period in which fears were allayed and motivation attempted. When this conditioned response technique did not work, the ear-choice technique was used. The subject responded by pointing to the ear in which the sound was heard. (p. 489)

Curry and Kurtzrock (32) reported that the ear-choice technique had been used to get an indication of the hearing of a group of preschool mentally retarded children. They provided no further information on this point, however.

The limited literature on audiometric techniques for use with the mentally retarded pointed up the need for this study. No study was located which concerned itself with the hearing acuity of the trainable mentally retarded and audiometric techniques to be used with them. Kodman, _et al._ (48), reported that nine per cent of their total sample were untestable by pure tone audiometry. This untestable group had an average mental age of 2.4 years and an average IQ of 25.5; the group had a range in mental ages from one to four years.

The studies which have been conducted on the auditory acuity of the mentally retarded by Birch and Matthews (25), Johnson and Farrell (45), Kodman, _et al._ (48), Schlanger (53), and Schlanger and Gottsleben (54) indicate an increased incidence of hearing loss among the mentally retarded. Kodman, _et al._ (48), questioned whether this was a true loss of hearing or the result of inadequate audiometric techniques. The purpose of this study was to evaluate some of these audiometric techniques.

CHAPTER III

AUDIOMETRIC AND STATISTICAL TECHNIQUES USED IN THIS STUDY

The audiometric techniques used in this study were chosen because of their ease of administration. Also, they did not require equipment beyond the financial ability of most public schools and speech and hearing clinics.

The auditory testing was done in the W.K. Sheppard Laboratory for Hearing Research, Sutton Hall 15AC, The University of Texas. The testing was done in a two-room hearing laboratory and in all techniques but the Otometer screening techniques two people worked with the trainable mentally retarded children. One room contained the audiometer, the tape recorder, the PGSR equipment, and all other equipment. The testing room contained a table and chairs, the earphones, the Pediacoumeter, and the free field speaker. The operator observed the reactions of the children through a window between the two rooms. An assistant was always in the testing room with the children. It was the duty of the assistant to demonstrate the technique to the child and to keep the child responding during the test.

The audiometer used was a Maico Model H-1B. For psychogalvanic skin response testing and recording, a Maico Psycometer with an Esterline-Angus Recorder, Model AW, was used. The tape recorder used was made by the International Radio and Electronics Corporation, the Crown Prince Model. The audiometer which was used for the audiometric screening techniques was an Ambco Otometer, Model 600 D.

The calibration of the Maico H-1B audiometer was checked three times during the testing program. This was done with an Allison Model 300 Audiometer Calibration Unit with a 9A Coupler and an Altec 21D Condenser Microphone. The correction factors are shown in Appendix A. Because some of the testing had been completed before this equipment was available, the mean of the correction factors for each earphone and each frequency was subtracted when testing was completed. The calibration of the Ambco Otometer was checked twice during the testing program. The correction factors are shown in Appendix B. Because this audiometer was used only for screening, no corrections needed to be applied to the test results.

Threshold Acuity Techniques

In this part of the study, four audiometric techniques were used: first, the blinking light technique, monaurally and in the free field; second, the ear-choice technique, monaurally; third, the technique with the Pediacoumeter, monaurally; and fourth, a modified speech reception technique, monaurally and in the free field. A pretest and a post-test were given with each of these techniques. In the pretest, the technique was demonstrated to the child and an attempt was made to test the child. Before the post-test, the child received a training period. The child was trained with music for the blinking light technique, the ear-choice technique, and the technique with the Pediacoumeter. The music was recorded on the tape recorder to allow it to be stopped and started with ease. The music had been re-recorded from the long playing record, "Ballet for Beginners," Regent MG 6011. The choice of this record was made after a trial of this and other records was made during the music periods in the school classroom. The music was presented to the child at a high intensity level and the child was trained to respond to the music in the same manner in which he was expected to respond to the pure tones. When the child demonstrated that he understood what was expected of him, the pure tones were substituted for the music and the hearing test was started. In the speech reception technique, the post-test followed an intensive training period naming the objects which were used in the test.

In the three pure-tone techniques used in this part of the study, the following frequencies were tested: 250 cps, 500 cps, 1000 cps, 2000 cps, and 4000 cps. At each of these frequencies, the child's threshold of hearing was determined for each ear, and, with the blinking light technique, in the free field. The mean hearing levels obtained for the pure tones in the free field should be considered as awareness levels rather than actual thresholds, as it was impossible to control all factors which affect pure tones when used in the free field. In the modified speech reception technique, a threshold was obtained monaurally and in the free field.

The descending threshold technique was used in all threshold acuity audiometry. The hearing loss dial was set about 30 decibels above the suspected threshold of the child and the intensity level was attenuated in 10 decibel steps until the child no longer indicated that he heard the sound. The hearing loss dial was raised in five decibel steps until the child indicated that he heard the sound. Each threshold was located at least twice to confirm the result.

1. The blinking light technique. In this technique every time a pure tone was presented to the child, a red light blinked. This red light was so placed that it was necessary for the child to turn his head to see the light. Conditioning the child to look at the light when he heard the sound was done at a hearing loss dial setting well above the child's suspected threshold of hearing. After the child was conditioned to turn his head to see the light when he heard the pure tone, the turning of the child's head toward the light was taken as indicating that the child heard the pure tone presented to him.

The sequence in which the frequencies were tested was 1000 cps, 2000 cps, 4000 cps, 500 cps, and 250 cps. In the pretest, the right ear was tested first, then the left ear, and finally the free field. In the post-test, the free field test was first, then the left ear, and the right ear was tested last.

2. The ear-choice technique. The pure tones were presented to the child through the earphones. The pure tones were changed from ear to ear in a random manner, and the child was asked to point to the ear in which the sound was heard. The technique followed was the one which was used by Curry and Kurtzrock (32), and it was a series of checks of the different frequencies at descending intensity levels.

In the pretest, the random manner of selection of the pattern to follow in ear-choice (either left or right) was at the discretion of the tester. In the post-test, the selection of the ear-choice pattern was done using a table of random numbers with the odd numbers for the left ear and the even numbers for the right ear.

3. The technique with the Pediacoumeter. The Pediacoumeter was used with the audiometer and the sound was presented through the earphones. The Pediacoumeter represented an attempt to provide an attention holding device to use in testing the auditory acuity of the

trainable mentally retarded child. The Pediacoumeter used in this study was a Haug Pediacoumeter, Model C, Serial 103.

The Pediacoumeter is made of seven puppets mounted in a box. The child was trained to press a switch when he heard a pure tone in the earphones. When the pure tone was presented to the child through the earphones and the child pressed a switch, a puppet would pop up like a Jack-in-the-box. When the pure tone was not presented to the child and he pressed on the switch, the puppets would not pop out. Guilford and Haug (36) reported that the Pediacoumeter has had great clinical success in obtaining audiograms on children from whom results had heretofore been highly unreliable or unobtainable because the other techniques had not contained sufficient interest for the children.

In the pretest of the technique with the Pediacoumeter, the right ear was tested first and then the left ear. In the post-test, the left ear was tested first and then the right ear.

4. Modified speech reception technique. This test was an adaptation of the Children's Auditory Test by Edna K. Monsees (60). The Children's Auditory Test is usually presented from a record, but in this study, the toys, the language, and the technique were retained, but the test was given by monitored live voice so as to make it more flexible for use with trainable mentally retarded children.

In this test, nine toys were placed on a table in front of the child. The toys used were an airplane, baby, ball, boat, bus, car, dog, duck, and a fish. The tester used the carrier phrase, "Show me the ________" and named one of the toys. The child was trained to pick up the toy which had been named. The starting intensity of the monitored live voice was at an intensity level high enough for the child to hear the words with ease. The intensity level was attenuated to the level where the child could respond correctly fifty per cent of the time. This point was taken as the child's threshold for speech. The threshold for speech obtained using this list of words was not the same as the threshold for speech would have been had a spondee word list been used. A spondee word is a two-syllable word with equal stress on each syllable. Monsees (60) found that this test gave a threshold about ten decibels lower than the threshold which would be obtained with the Central Institute for the Deaf Auditory Test Number 14, which is a spondee word test. This list of words was used because these words were believed to be within the limited vocabulary of trainable mentally retarded children. Because most speech reception thresholds are established with spondee words, it was more accurate to speak of this test as a modified speech reception technique.

The threshold of speech can be used to corroborate the pure-tone threshold since there is a close relationship between the two.

Newby (10) stated that the speech reception threshold should agree within five to ten decibels of the average of the pure tone loss. Newby also stated that if only one test is possible on a child, the speech reception test should be chosen over a pure-tone test because with a speech reception test, a more valid threshold would be obtained.

In the pretest of the modified speech reception test, the right ear was tested first, then the left ear, and finally the free field. In the post-test, the free field was tested first, then the left ear, and finally the right ear.

PGSR Audiometry

This was a study of psychogalvanic skin response (PGSR) audiometry. PGSR, as developed by Bordley (26, 39), Hardy (38, 39, 40), and others, was an attempt to provide an objective audiometric technique. An objective audiometric technique would be one in which the client is not required to make any sign that he has heard the auditory stimulus. Hirsh (6) stated:

> The most highly developed clinical application of Pavlovian conditioning is to be found in the work of Bordley, Hardy, and Richter. These workers began with an unconditioned stimulus-response connection: the lowering of the skin resistance (Feré effect) in response to an electric shock. (p. 264)

The use of PGSR as an audiometric technique has been questioned. Guilford and Haug (36) stated that below 50 decibels poor responses are obtained and frequencies above 2048 cps and below 128 cps give small galvanic skin reflexes. They also stated that inconsistency of responses is frequent. Bordley (26) stated:

> The chief difficulties encountered in testing the hearing of children by PGSR are found: 1, in establishing conditioning in the presence of certain brain injuries; 2, in the building of a team capable of handling the test situation. . . (p. 1183)

Aronson, et al. (23), also stressed the difficulty of conditioning. They stated that neurologically involved people, people with hearing handicap and even normal people have been difficult to condition.

Another criticism made by Bordley (26) of PGSR audiometry indicated that this technique

> . . . would seem to measure only the efficiency of the auditory end-organ and the subcortical pathways, while standard audiometry measures the efficiency of the hearing mechanism as a whole from the external ear through the auditory cortex. It evaluates reception rather than the perception of sounds. . . . It does not necessarily evaluate hearing at the cortical level. (pp. 1182-83)

Gollman (31) studied the galvanic skin response with retarded children and other children. He found that the mean GSR of the low IQ children and the high IQ children was less than for the middle IQ children. The peak GSR was for the group near a mean IQ of 90.

Lehrhoff (61) did a study of PGSR with cerebral palsied children. He found that the galvanic skin response did not yield valid and reliable results with this type of neurologically impaired children.

The PGSR was used in this study, however, so that further objective results could be reported on its use. Neurological classifications were available on the children and it was possible to consider the effect of neurological defect on PGSR audiometry. It was possible, also, to test the significance of the differences between thresholds obtained by PGSR and by other pure-tone threshold acuity techniques.

Newby (10) gave the following description of PGSR audiometry:

> The skin of an individual has a resistance to the flow of electric current. As this resistance increases, the amount of current that can flow through the skin decreases, and vice versa. Under circumstances of quiet and relaxation, an individual's skin resistance remains relatively constant. Stimuli which excite any kind of emotional response, however, will cause the resistance of the skin to decrease. The amount of current flowing through the skin which is, of course, a measure of skin resistance, can be amplified and recorded with an ink-writing recorder. The technique of utilizing the skin response in hearing testing is to condition the patient to respond to sound as an emotion-producing stimulus. This is done by associating the test stimulus from an audiometer with a mild electric shock. The shock is sufficient to induce a momentary emotional response, which causes a drop in skin resistance. The patient first is presented with a spurt of sound and then is given a shock. It will take only a few trials, after which even an infant will respond to the sound as if it were the shock. In other words, when the sound is presented, the skin resistance drops in anticipation of the shock that is to follow. If the skin resistance does not drop until after the shock occurs, it is assumed that the patient is not hearing the sound. (p. 186)

The basic technique of PGSR audiometry which was used in this study was that as explained by Newby. However, when the child became conditioned to expect the shock following the presentation of the pure tones, every presentation of the pure tones was not followed by the electric shock. Meritser and Doerfler (50) found that partial reinforcement of the galvanic response gave the best results. Reinforcement by shock of the galvanic response was done in a random manner. It was not necessary to condition for every frequency. Bordley (26) stated that experience has shown that once a child is conditioned for one frequency, he is conditioned for all frequencies.

Two different studies were done with PGSR audiometry:

1. *PGSR threshold acuity test*. In this test, the following frequencies in the following sequence were tested: 500 cps, 1000 cps, 2000 cps, 4000 cps, and 250 cps. The right ear was tested first and then the left ear.

The purpose of this test was to secure monaural pure tone thresholds for each of the five frequencies. After the child had become conditioned and the galvanic response was visible following the presentation of the sound, the intensity of the sound was attenuated to the last level at which the child showed a galvanic response. This level was taken as the child's threshold of hearing for that frequency in that ear.

Tests of the significance of the differences between the PGSR thresholds and the other pure tone thresholds were computed. The effect of neurological problems on PGSR audiometry was considered.

2. *PGSR screening technique.* A screening technique was used with the PGSR which did not seek thresholds of hearing, but only attempted to determine if the child heard pure tones at 10 decibels, which was the intensity which Newhart and Reger (22) recommended as the preferred critical level for auditory screening in a quiet location. In this screening technique, the following three frequencies were tested in both ears in the following sequence: 500 cps, 1000 cps, and 2000 cps. The right ear was tested first and then the left ear.

It has been shown by Aronson, *et al.* (23), that the intensity of the pure tones significantly affect the dimensions of the galvanic skin responses. With increased intensity, the galvanic skin response latencies become shorter and the variability of the latencies become smaller. With increased intensity, it is easier to reject spontaneous responses and to identify valid responses. This screening technique with PGSR was designed to take advantage of these findings and to screen the trainable mentally retarded at the highest possible critical level for hearing loss.

The conditioning of the children started at 70 decibels. During the conditioning process, the child was given a maximum of twenty presentations of the sound with a sixty per cent shock reinforcement. After a child gave three consecutive galvanic responses to sound presentation, conditioning was considered to be complete. If the child failed to become conditioned within twenty presentations, the test was stopped. This was the same criteria used by Aronson, et al. (23), in their study. If the child was conditioned, two presentations of the sound were made at 50 decibels and two presentations were made at 30 decibels. This was done to make the children aware that the intensity would be less. The intensity was dropped to 10 decibels and the screening test was started.

In the screening test, there were eight presentations of each of the three frequencies in each ear, or a total of forty-eight presentations. Each of the sound bursts was timed at three seconds and a recovery period of 25 seconds was allowed between bursts of sound. Three of the eight presentations were reinforced by the electrical shock in a random order, and the reinforced presentations were not considered in the evaluation of the results. Of the five presentations, four had to give a significant galvanic response before the child was classified as passing.

The criteria for a significant galvanic response in this study were based on the characteristics of the equipment being used. The equipment which was used in this study was the Macio H-1B audiometer and the Esterline-Angus Recorder, Model AW. The chart paper was Esterline-Angus Record Chart No. 4305-X. To be considered significant for the purposes of this study, the graphic peaks on the recorder had to be two chart divisions (about 5 mm.) or greater, and the latency period had to be from one second following presentation of the sound to 7.5 seconds following presentation of the sound. These criteria are the same as those used by Hanley, Tiffany, and Brungard (37). The minimum response slope had to be forty-five degrees or greater.

Otometer Screening Techniques

The threshold acuity techniques and the PGSR techniques used in this study required considerable equipment, a sound treated laboratory, and at least two trained technicians. Two screening techniques were developed which required only one technician and the equipment was portable enough so that the technician could carry it with him.

For the two screening techniques, a small, portable, battery operated audiometer, the Ambco Otometer, Model 600 D, was used. One of the screening techniques required that the Otometer be modified slightly so that when the interrupter switch was depressed to bring in the sound, an electrical circuit was completed at the same time so that the child could activate a battery operated toy car which could be operated by remote control switches. When the interrupter switch was not depressed and the sound was not "on," the circuit was not completed and the toy car could not be activated. The child was trained to know that the car would work only when he heard the pure tone in the earphone. The toy car had its own source of power and it needed only the completed circuit through the interrupter switch to function.

The second screening technique with the Otometer was not wired into the circuit. This technique used a toy traffic light which had a red "stop" light, a green "go" light, and an amber "wait" light. This traffic light was placed behind the child and when the sounds were presented to the child through the earphones, one of the lights would blink. The child was trained to look toward the traffic light every time a sound was heard. It was necessary for the person administering the test to have a small switch in his hand and to blink the traffic light manually when the interrupter switch was depressed.

The training for these two screening techniques was done at an intensity level well above the suspected threshold of the child. After the child demonstrated that he knew what was expected of him, the hearing loss dial on the Otometer was set at 20 decibels and a conventional sweep check of hearing was administered. The following frequencies were tested in the following sequence: 500 cps, 1000 cps, 2000 cps, 4000 cps, and 6000 cps. The conditioning for the sweep check test was done at 500 cps at an intensity of 50 decibels. When the child indicated that the sound was heard either by playing with the car or by looking toward the light, the sound was interrupted.

More than one chance was given at each frequency in each ear in order to be certain that the child was hearing and not giving only chance responses. The intensity level was not changed during the test once conditioning had been established. Only the frequency and the ear were changed. The children were screened twice with each of the screening techniques. The hearing loss dial was set at 20 decibels for the first screening and the second time the hearing loss dial was set at 15 decibels. In most cases, one day elapsed between the first screening and the second screening.

Statistical Techniques Used in the Study

In the statistical analysis of the pure-tone threshold results, each of the five frequencies tested were considered separately monaurally and in the free field. In the modified speech reception technique, the threshold for the right ear, the left ear, and the free field threshold were all considered separately. All results reported in the terms of decibels have zero on the audiometer as the reference level.

Nonparametric tests of the significance of the differences were used rather than the parametric "t" or "F" tests. The data in this study did not meet all of the assumptions which underlie the use of parametric tests. It was very difficult to secure the 26 trainable mentally retarded children, so no assumption could be made that they were a normally distributed population of trainable mentally retarded children. Also, in threshold audiometry, there is seldom a normal distribution of scores, because one end of the distribution is truncated; it is possible to measure subnormal hearing up to 100 decibels, but it is possible to measure above normal hearing only up to -10 decibels. Other factors which made nonparametric techniques necessary were the small sample used in the study and the number of unequal N's.

When the significance of the differences between the pretest and the post-test thresholds was tested, the Wilcoxon Matched-Pairs Signed-Ranks test for related samples was used. It was used also when the interest significance of the differences was tested. The level of significance was determined for a two-tailed test. When intergroup differences were tested, the Median test for independent samples was used. The level of significance for the Median test was computed for a two-tailed test.

CHAPTER IV

RESULTS

The results of this study are presented separately for the threshold acuity techniques, the PGSR techniques, and the Otometer screening techniques. The thresholds of hearing on one child were omitted in the computation of the mean hearing levels and the standard deviations. The child was in the Opportunity Center Group and was classified as a non-mongoloid with a neurological defect. The child had an excessive hearing loss and when these high thresholds were considered with such a small sample, the means and standard deviations were skewed and did not reflect the group mean hearing levels and standard deviations. The findings with this child were used in the computation of all other results, however.

Threshold Acuity Technique Results

The blinking light technique. The data in Table I show the results of the blinking light technique. The data show that only three of the children in the Public School Group responded monaurally to the pretest, while six of the Opportunity Center Group and either seven or eight of the State School Group responded monaurally to the pretest.

TABLE I

MEAN HEARING LEVELS AND STANDARD DEVIATIONS IN DECIBELS ON THE PRETEST AND POST-TEST OF THE BLINKING LIGHT TECHNIQUE

Group		Right Ear Frequency in kc					Left Ear Frequency in kc					Free Field Frequency in kc				
		.25	.5	1	2	4	.25	.5	1	2	4	.25	.5	1	2	4
Pretests Public	M[a]	12.8	5.6	12.6	12.4	16.6	6.0	11.9	6.8	11.7	20.8	15.0	13.3	11.5	16.2	20.0
School	SD[b]	4.1	6.2	2.4	9.4	18.4	4.7	8.5	2.4	13.1	15.5	4.1	5.5	9.3	12.0	15.5
	n[c]	3	3	3	3	3	3	3	3	3	3	6	6	8	6	5
Oppor.	M	6.2	3.1	5.1	2.4	10.8	5.2	5.2	5.1	5.0	14.2	4.0	2.3	8.6	8.6	6.5
Center	SD	6.2	6.1	7.9	6.9	7.5	8.5	9.4	9.9	7.6	10.2	5.8	5.1	7.9	4.4	7.1
	n	6	6	6	6	6	6	6	6	6	6	5	5	7	7	5
State	M	4.1	2.1	4.9	1.4	8.3	6.2	0.0	1.6	-2.8	8.9	3.0	3.7	10.1	10.6	8.3
School	SD	11.9	11.7	9.6	9.6	8.3	10.3	9.5	11.2	11.9	6.9	9.5	7.9	13.4	10.7	11.1
	n	8	8	8	8	8	7	7	8	8	7	9	9	9	9	9
Non-	M	6.6	5.2	8.0	6.4	14.5	9.1	7.9	6.6	8.1	18.9	7.3	8.4	12.8	13.5	12.4
Mongol.	SD	11.4	11.7	9.9	12.1	12.7	8.8	10.5	10.9	12.2	11.3	8.7	8.9	12.0	12.7	16.2
W/Defect	n	8	8	8	8	8	7	7	8	8	7	9	9	12	10	9
Mongol.	M	11.9	2.7	5.5	2.0	7.0	3.9	3.6	1.0	1.3	11.3	9.0	6.0	8.6	10.3	10.4
No Neuro.	SD	6.5	4.2	7.4	4.2	10.8	7.4	11.8	9.0	6.5	7.4	8.0	6.5	7.4	6.1	8.5
Defect	n	4	4	4	4	4	4	4	4	4	4	5	6	7	7	5
Mongol.	M	4.1	2.7	9.3	-3.3	10.8	2.7	2.3	7.2	0.0	8.8	2.3	5.3	7.5	10.0	6.3
With	SD	4.2	4.2	6.1	7.5	5.6	3.5	4.2	7.4	10.6	8.9	7.8	5.7	10.3	9.6	4.2
Defect	n	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
		6.4	3.1	6.3	5.5	10.6	5.8	4.2	3.8	3.2	13.1	6.9	6.4	10.1	11.5	10.9
Total		9.7	9.3	9.1	10.0	10.9	8.8	10.3	9.9	11.9	11.2	9.1	8.1	10.8	10.4	12.8
		17	17	17	17	17	16	16	17	17	16	20	20	24	22	19
Post-tests																
Public	M	8.7	5.6	9.3	5.8	11.6	9.1	8.6	6.0	5.0	12.5	3.3	6.4	10.6	11.9	10.1
School	SD	11.3	12.1	9.0	8.5	10.3	7.9	7.6	7.5	9.4	8.9	4.8	6.8	5.3	7.0	7.7
	n	6	6	7	7	6	7	7	8	6	7	8	8	8	8	8
Oppor.	M	-.5	-.2	.1	-4.2	6.6	2.7	-.6	-1.5	-2.5	7.5	2.5	2.0	5.0	5.0	5.0
Center	SD	7.8	9.3	7.3	6.5	7.5	7.6	8.4	7.1	7.5	7.1	3.8	5.1	4.9	5.0	7.5
	n	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
State	M	-2.2	-6.0	-4.6	-6.5	2.7	-1.2	-5.3	-2.1	-5.0	3.6	-2.3	-1.9	1.0	1.9	1.8
School	SD	4.7	4.7	4.6	5.8	5.5	7.4	7.4	5.0	5.3	5.2	6.3	6.2	5.6	4.4	3.1
	n	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
	n	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Non-	M	-.5	-2.7	.5	3.0	4.1	1.8	-.2	.8	-2.3	6.7	.5	1.0	4.9	5.5	4.8
Mongol.	SD	6.0	6.6	8.5	6.8	4.8	7.3	7.9	7.0	5.4	7.0	4.1	6.3	4.6	5.7	2.6
W/Defect	n	12	12	12	12	12	12	12	13	13	12	13	13	13	13	13
Mongol.	M	6.6	6.5	7.3	2.6	13.3	7.7	4.0	4.5	3.0	11.5	4.8	5.4	9.2	11.0	10.0
No Neuro.	SD	16.4	16.0	10.3	12.1	14.6	11.0	13.4	9.7	14.4	10.7	6.7	7.9	9.4	9.7	8.9
Defect	n	4	4	5	5	4	5	5	5	5	5	5	5	5	5	5
Mongol.	M	4.1	-1.0	-.73	-1.7	8.3	3.9	-.2	-.3	1.3	7.5	0.0	2.5	6.3	5.0	2.4
With	SD	5.5	6.1	7.1	5.6	5.0	7.4	7.4	4.2	5.5	3.5	6.1	7.5	2.2	3.5	4.2
Defect	n	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
	M	1.4	-1.0	1.3	-2.0	6.4	3.1	.4	.9	-.9	7.5	.9	2.2	5.4	6.6	5.5
Total	SD	9.3	9.9	9.4	8.7	8.5	8.0	9.7	7.6	8.7	8.0	5.8	7.1	6.8	7.0	7.1
	n	21	21	22	22	21	22	22	23	23	22	23	23	23	23	23

[a] Mean hearing levels in decibels.

[b] Standard deviation in decibels.

[c] Number of ears measured or of subjects in free field.

In all groups, more children gave responses to the free field test than to the monaural tests. The Mongoloid with Neurological Defect Group was the only group in which all of the children in the group responded to both the pretest and the post-test, monaurally and in the free field.

It was evident from the results that in this pretest, the children responded better without the earphones than when the tests were given monaurally. During the pretests, the children must not have been sufficiently accustomed to the earphones to give their best responses in the test situation.

The same trend was evident in the post-test results of the blinking light technique as was evident for the pretest results. The data in Table I show that, with the exception of the Mongoloid with Neurological Defect Group in which all of the children responded to the post-test, more children responded in the free field test than in the monaural tests. Even after training and considerable listening experience, the children gave more responses without the earphones.

The data in Table I also show that at 4000 cps, most of the mean thresholds are greater than for the other frequencies tested. None of the mean monaural thresholds indicated that the group had a hearing level above 20 decibels which would be considered a significant hearing loss according to the Texas State Department of Health (21). The Public School Group did have a mean hearing level of 20 decibels at 4000 cps on the pretest, but the mean hearing level dropped to 10.1 decibels on the post-test.

Most of the mean monaural hearing levels for the State School Group on the pretest were lower than were the mean hearing levels of the other two school groups, while the mean hearing levels for the Opportunity Center Group on the free field tests were the lowest of the three school groups. On the post-tests, the State School Group had the lowest mean hearing levels in all instances, monaurally and in the free field.

The Non-Mongoloid with Neurological Defect Group had the highest mean hearing levels on the pretests of the neurological groups. On the post-tests, however, the Mongoloid with No Neurological Defect Group had the highest mean hearing levels.

All of the mean hearing levels for the Total Group on the post-tests were lower than the mean hearing levels on the pretest. This indicated that training and practice lowered the thresholds of hearing of the trainable mentally retarded children with the blinking light technique.

indicated that training and practice lowered the thresholds of hearing

The variability of the groups is shown by the standard deviations. On the pretest, there was a tendency for the State School Group to have more variability than the other school groups. The same tendency was shown by the Non-Mongoloid with Neurological Defect Group on the pretests. On the post-tests, however, the Public School Group showed more variability than did the other school groups, and the Mongoloid with No Neurological Defect Group showed more variability than did the other neurological groups. The Total Group variability was less in most cases on the post-tests than on the pretests. The samller standard deviations on the post-tests in most cases indicated that as the trainable mentally retarded children in this study received listening experience and training, there was less variability in the responses. It would seem that the listening experience gained by a test and a retest and the training received helped the children to give more consistent responses and to respond at a lower intensity level.

The post-test mean hearing levels of the thirteen children who completed all of the pretest and all of the post-test on the blinking light technique are shown in Table II. When these mean hearing levels were compared with the post-test mean hearing levels of the Total Group shown in Table I, all of them were lower than the mean hearing levels of the Total Group. This indicated that the children who responded only on the post-test of the blinking light technique did not respond at as low an intensity level as did the children who responded to both the pretest and the post-test. This explained why some of the mean hearing levels on the post-test were higher than the mean

TABLE II

MEAN HEARING LEVELS ON THE POST-TEST OF THE BLINKING LIGHT TECHNIQUE FOR THE GROUP WHICH COMPLETED BOTH THE PRETEST AND THE POST-TEST

	Frequency in cps	Number of Ears	Mean Hearing Level in db	Standard Deviation
Right Ear:				
	250	13	-0.4	5.8
	500	13	-4.9	4.8
	1000	13	-2.7	5.4
	2000	13	-5.4	4.8
	4000	13	4.0	5.5
Left Ear:				
	250	13	0.4	7.2
	500	13	-3.5	7.8
	1000	13	-1.5	5.2
	2000	13	-4.2	6.2
	4000	13	5.2	5.4
Free Field:				
	250	13	-1.5	5.7
	500	13	-0.8	6.0
	1000	13	1.9	5.0
	2000	13	2.1	5.6
	4000	13	2.4	3.0

hearing levels on the pretest when the school groups and the neurological groups were considered.

The Wilcoxon Matched-Pairs Signed-Ranks test was used to test the significance of the differences of the thresholds between the pretest and the post-test for the total group. The results are shown in Table III. Twelve of the 15 tests showed a significant difference. The results indicated that with the blinking light technique there was a significant difference between the pretest and the post-test thresholds. With trainable mentally retarded children, the post-test was very important when using the blinking light technique as significantly lower thresholds were obtained.

The Wilcoxon Matched-Pairs Signed-Ranks test was used to test the significance of the differences between the pretest and post-test thresholds for each of the three school groups and each of the neurological groups on the blinking light technique. A separate test was computed for each of the five frequencies monaurally and in the free field. Of the 45 tests which were computed for the school groups, only three showed a significant change. All three of these tests were in the State School Group. For the Opportunity Center Group and the Public School Group, most of the numbers were not large enough for the Wilcoxon Matched-Pairs Signed-Ranks test to show a change which reached significance at the .05 level. This was true, also, for the

TABLE III

SIGNIFICANCE OF THE DIFFERENCES OF THE PURE-TONE THRESHOLDS OF THE TOTAL GROUP BETWEEN THE PRE-TEST AND THE POST-TEST OF THE BLINKING LIGHT TECHNIQUE

	Frequency in cps	Number	T[a]	p[b]
Right Ear:				
	250	12	-9.0	.05
	500	12	-6.5	.01
	1000	11	-1.0	.01
	2000	12	-7.0	.01
	4000	12	-7.5	.05
Left Ear:				
	250	10	-14.0	NS[c]
	500	8	-7.5	NS
	1000	13	-16.5	.05
	2000	14	-19.0	.05
	4000	10	-4.5	.05
Free Field:				
	250	15	-12.5	.01
	500	12	-7.5	.05
	1000	18	-40.5	NS
	2000	13	-9.0	.01
	4000	9	-3.0	.05

---

[a] T--the smaller of the sums of like signed ranks on the Wilcoxon Matched-Pairs Signed-Ranks test.

[b] p--probability associated with the occurrence of a value as extreme or more extreme as the value observed.

[c] NS--Did not reach significance at the .05 level.

neurological groups and only one group, the Non-Mongoloid with Neurological Defect Group, had a large enough number to test the significance of the differences. With this group, seven of the 15 tests reached significance at the .05 level. This followed the pattern of the Total Group which showed significant changes between the pretest and post-test thresholds.

The Median test was used to test whether there were any significant differences between the thresholds of the three school groups on the pretest and between the three school groups on the post-test. A test was done for each of the five frequencies monaurally and in the free field. The Public School Group was compared with the State School Group, the State School Group was compared with the Opportunity Center Group, and the Opportunity Center Group was compared with the Public School Group. Of the 45 tests of significance on the pretests, none of the differences were found to reach significance at the .05 level. Of the 45 tests which were computed on the post-test, three showed significant differences. All three tests which were significant occurred when the State School Group was compared with the Public School Group. The differences between these two groups were significant at the .02 level in the left ear at 500 cps, at the .05 level on the free field at 2000 cps, and at the .02 level on the free field at 4000 cps.

The Median test was used to test the significance of the differences of the thresholds between the three neurological groups on the pretest and the post-test. A test was computed for each of the five frequencies monaurally and in the free field. The Non-Mongoloid with Neurological Defect Group was compared with the Mongoloid with Neurological Defect Group, the Mongoloid with Neurological Defect Group was compared with the Mongoloid with No Neurological Defect Group, and the Mongoloid with No Neurological Defect Group was compared with the Non-Mongoloid with Neurological Defect Group. Forty-five tests were computed for the pretest and forty-five tests were computed for the post-test and none reached significance at the .05 level.

The trainable mentally retarded children were divided into the group above the mean IQ and the group below the mean IQ. The significance of the differences of thresholds between the pretest and the post-test was computed for each group by the Wilcoxon Matched-Pairs Signed-Ranks test. A test was computed for each of the five frequencies monaurally and in the free field. Of the fifteen tests which were computed for the group above the mean IQ, two of the tests reached significance at the .05 level. For the group below the mean IQ, five of the tests reached significance at the .05 level. These results indicated that children above the mean IQ perhaps responded at thresholds nearer to their actual thresholds on the pretest than did the children below the mean IQ and, therefore, there were fewer significant changes in threshold between the pretest and the post-test for the group above the mean IQ than for the group below the mean IQ.

The ear-choice technique. Only nine of the trainable mentally retarded children responded to the pretest of this audiometric technique. Twenty-three of the children responsed to the post-test. Because of the small number of children who completed the pretest, no analysis was made of the data for the school and neurological groups.

The mean hearing levels and the standard deviations for the total group on the pretest and the post-test on the ear-choice technique are shown in Table IV. The mean thresholds for the post-test are higher in all instances than in the pretest. The group of children who completed both the pretest and the post-test also showed higher mean hearing levels in most cases on the post-test than on the pretest. This lack of improvement in threshold indicated that the listening experience of a pretest and a post-test and the training which was given before the post-test were of no value as far as threshold improvement was concerned. However, more children did respond on the post-test than on the pretest, so the listening experience and the training before the post-test must have accounted for this increase.

TABLE IV

MEAN HEARING LEVELS AND STANDARD DEVIATIONS IN DECIBELS ON THE PRETEST AND POST-TEST OF THE EAR-CHOICE TECHNIQUE

		Right Ear Frequency in kc					Left Ear Frequency in kc				
		.25	.5	1	2	4	.25	.5	1	2	4
Pretest-- Total Group	M[a]	8.4	3.4	3.7	3.0	6.6	8.2	4.7	4.8	1.3	1.7
	SD[b]	6.0	6.9	9.8	10.3	5.7	6.0	4.6	8.6	9.7	4.7
	n	9	9	9	9	9	9	9	9	9	9
Post-test-- Total Group	M	11.7	7.7	7.5	4.7	13.5	13.8	9.4	7.6	6.1	15.7
	SD	10.2	9.2	10.7	10.1	11.0	8.1	9.3	9.7	9.9	12.1
	n	23	23	23	23	23	23	23	23	23	23
Group which Completed Pretest and Post-test	M	10.6	.1	4.8	1.9	11.6	12.7	6.9	6.8	5.0	13.1
	SD	11.1	13.0	14.4	12.2	12.5	9.1	9.7	12.0	10.0	13.8
	n	9	9	9	9	9	9	9	9	9	9

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[a] Mean hearing level in decibels.

[b] Standard deviation in decibels.

[c] Number of ears.

The Wilcoxon Matched-Pairs Signed-Ranks test was used to test the significance of the differences between the pretest and the post-test thresholds of the total group on the ear-choice technique. A test wascomputed for each of the five frequencies in the left ear and the right ear. Ten tests of significance were computed and none of the tests reached significance at the .05 level.

Because of the small number who completed the pretest of the ear-choice technique, the children were not divided into groups above and below the mean IQ for this test. The ear-choice technique appeared to be a difficult technique to use with trainable mentally retarded children.

The technique with the Pediacoumeter. The data in Table V show the mean hearing levels and the standard deviations on the pretest and the post-test for the technique with the Pediacoumeter. Fifteen children completed the pretest and 24 children completed the post-test. Because the number of children who responded to the pretest was so small, the mean hearing levels and standard deviations for the school and neurological groups were not as meaningful for the pretest as were the mean hearing levels and standard deviations for the post-test.

The mean hearing levels for the frequency of 4000 cps were larger in most cases than the mean hearing levels for the other

TABLE V

MEAN HEARING LEVELS AND STANDARD DEVIATIONS IN DECIBELS ON THE PRETEST AND POST-TEST OF THE TECHNIQUE WITH THE PEDIACOUMETER

		Right Ear					Left Ear				
		Frequency in kc					Frequency in kc				
		.25	.5	1	2	4	.25	.5	1	2	4
Pretests Public School	M[a]	1.8	-3.0	8.3	1.8	6.3	3.7	.4	3.5	-2.0	4.5
	SD[b]	5.8	5.1	7.4	8.0	8.1	6.6	9.3	7.1	6.8	6.0
	n[c] = 5										
Opportunity Center	M	1.6	.2	4.3	2.0	9.5	.2	-2.7	-.3	-2.5	1.3
	SD	5.5	6.5	11.2	6.5	7.4	5.6	5.5	7.4	9.0	7.4
	n=6										
State School	M	-2.2	-1.9	1.5	-2.6	9.1	-1.5	-3.9	-.7	-6.7	3.3
	SD	5.0	5.3	6.3	4.7	6.7	4.5	4.8	3.3	4.7	1.9
	n= 6										
Non-Mongoloid With Neurological Defect	M	7	-.33	6.4	1.5	11.1	-1.2	-2.9	-.8	-3.1	1.[illegible]
	SD	2.5	5.6	8.8	6.8	6.5	6.5	5.8	5.6	6.8	4.4
	n= 7										
Mongoloid with No Neurological Defect	M	1.6	-3.5	4.3	-2.0	4.5	2.7	-3.9	1.0	-1.3	4.8
	SE	6.9	5.5	8.7	5.1	8.2	6.1	5.6	8.3	9.0	7.3
	n= 6										
Mongoloid with Neurological Defect	M	-.5	-6.3	4.3	-.9	4.9	2.7	1.2	3.5	-5.0	5.8
	SD	4.7	4.1	7.1	8.5	6.2	0.0	6.2	7.1	4.1	2.4
	n= 3										
Total Group	M	.2	-1.7	4.6	.1	8.3	.7	-.8	.0	-4.2	3.2
	SD	5.1	5.7	8.7	6.8	7.5	6.0	7.0	6.3	7.1	5.4
	n= 15										
Post-tests											
Public School	M	10.3	5.9	6.2	1.4	10.1	8.9	4.2	6.0	3.1	11.9
	SD	7.1	5.6	5.6	6.3	5.6	7.8	11.0	5.6	10.9	6.3
	n= 8										
Opportunity Center	M	.7	-1.8	-2.2	-4.2	4.0	1.2	-4.3	-.8	-7.9	2.5
	SD	5.3	5.6	7.4	10.0	6.8	6.9	7.5	5.5	5.3	6.6
	n= 7										
State School	M	3.4	1.2	.9	1.3	8.8	4.3	-.3	3.5	2.9	11.4
	SD	8.6	8.2	11.6	9.3	9.6	9.1	8.8	8.8	10.3	9.4
	n= 9										
Non-Mongoloid With Neurological Defect	M	4.1	1.1	.9	-1.7	8.3	6.9	.7	2.2	.8	11.3
	SD	8.2	6.3	10.9	9.7	8.9	7.8	8.5	8.2	10.8	9.4
	n= 12										
Mongoloid with No Neurological Defect	M	7.8	4.0	4.3	.8	8.3	4.9	-.3	4.9	-.7	6.8
	SD	8.9	7.1	8.5	8.5	8.5	11.0	10.6	8.3	13.8	9.0
	n= 7										
Mongoloid with Neurological Defect	M	5.1	2.7	-.7	3.3	7.0	6.9	3.6	2.2	-2.8	6.3
	SD	4.3	2.2	5.0	7.5	4.2	7.5	6.1	2.2	2.5	4.2
	n= 4										
Total Group	M	4.9	2.7	1.8	-.3	7.8	5.0	.9	3.1	-.2	9.0
	SD	7.5	5.6	9.4	9.0	8.0	8.7	8.8	7.5	10.6	8.5
	n= 24										

[a] Mean hearing level in decibels.

[b] Standard deviation in decibels.

[c] Number of ears.

frequencies. This was true on both the pretest and the post-test. In most cases on the pretest, the State School Group had the lowest mean hearing levels of the three school groups. There was little difference between the mean hearing levels of the neurological groups on the pretest.

The variability, as shown by the standard deviations, was about the same for the three school groups. Also, the variability was about the same for the three neurological groups.

On the post-test, the mean hearing levels of the Public School Group were higher than for the other school groups. The Opportunity Center Group had the lowest mean hearing levels. There was little difference between the mean hearing levels of the neurological groups on the post-test.

There was a tendency for the variability of the State School Group to be higher on the post-test than it was for the other school groups. For the neurological groups, the Mongoloid with Neurological Defect Group showed less variability on the post-test than the other neurological groups.

Many of the mean hearing levels for the total group were greater on the post-test than on the pretest. Also, most of the standard deviations of the total group were larger on the post-test than they were on the pretest.

The data in Table VI show the mean hearing levels and the standard deviations on the post-test of the 14 children who completed all of the pretest and all of the post-test of the technique with the Pediacoumeter. The mean hearing levels of this group of children on the post-test were all lower than the mean hearing levels of the total group on the post-test. The standard deviations of the group of children who completed both the pretest and the post-test were smaller in nine out of 10 cases than were the standard deviations of the total group on the post-test. As was seen also in the blinking light technique, the children who responded only to the post-test did not respond at as low an intensity level as did the children who responded to both the pretest and the post-test. This explained why many of the mean hearing levels of the groups on the post-test were higher than the mean hearing levels on the pretest.

The Wilcoxon Matched-Pairs Signed-Ranks test was used to test the significance of the differences between the pretest and post-test thresholds for the total group with the Pediacoumeter. A test of significance was computed for each of the five frequencies in the left ear and the right ear. Of the 10 tests which were computed, one--the right ear at 1000 cps--reached significance at the .01 level. The other nine tests did not reach significance at the .05 level.

TABLE VI

MEAN HEARING LEVELS ON THE POST-TEST OF THE TECHNIQUE WITH THE PEDIACOUMETER FOR THE GROUP WHICH COMPLETED BOTH THE PRETEST AND THE POST-TEST

	Frequency in cps	Number of Ears	Mean Hearing Level in db	Standard Deviation
Right Ear:				
	250	14	1.4	5.8
	500	14	-0.3	5.9
	1000	14	-0.4	7.2
	2000	14	-2.8	5.2
	4000	14	4.7	4.8
Left Ear:				
	250	14	1.2	6.4
	500	14	-2.9	6.9
	1000	14	-0.5	5.7
	2000	14	-3.6	6.4
	4000	14	6.1	8.5

#2

The Wilcoxon Matched-Pairs Signed-Ranks test was used to test the significance of the differences between the pretest and post-test thresholds of the three school groups with the Pediacoumeter, and for the neurological groups with the Pediacoumeter. Because of the small number of children who completed the pretest with the Pediacoumeter, it was not possible to compute all tests. However, none of the tests which were computed reached significance at the .05 level for either the school groups or the neurological groups.

The Median test was used to compute the significance of the differences between the three school groups on the pretest and the post-test of the technique with the Pediacoumeter. A test was computed for each of the five frequencies in the left ear and the right ear. The Public School Group was compared with the Opportunity Center Group, the Opportunity Center Group with the State School Group, and the State School Group with the Public School Group. Of the 30 tests on the pretest data and the 30 tests on the post-test data, none reached significance at the .05 level. This indicated that all three school groups had about equal auditory acuity as measured by the technique with the Pediacoumeter.

The Median test was used to compute the significance of the differences between the three neurological groups on the pretest and the post-test of the technique with the Pediacoumeter. A test was computed for each of the five frequencies in the left ear and the right ear. The Non-Mongoloid with Neurological Defect Group was compared with the Mongoloid with No Neurological Defect Group, the Mongoloid with No Neurological Defect Group was compared with the Mongoloid with Neurological Defect Group, and the Mongoloid with Neurological Defect Group was compared with the Non-Mongoloid with Neurological Defect Group. Thirty tests were computed for the pretest results and 30 were computed for the post-test results, and none of the tests reached significance at the .05 level. This indicated that the three neurological groups had about equal auditory acuity as measured by the technique with the Pediacoumeter.

The Wilcoxon Matched-Pairs Signed-Ranks test was used to test the significance of the differences between the pretest and post-test thresholds of the technique with the Pediacoumeter for the group of children above the mean IQ and for the group of children below the mean IQ. A test was computed for each of the five frequencies in the left ear and the right ear. Ten tests of significance were computed for the group above the mean IQ and 10 for the group below the mean IQ. None of the 20 tests reached significance at the .05 level.

The modified speech reception technique. The mean hearing levels and standard deviations on the speech reception technique are shown in Table VII. More of the trainable mentally retarded children

TABLE VII

MEAN HEARING LEVELS AND STANDARD DEVIATIONS IN DECIBELS ON THE PRETEST AND POST-TEST OF THE SPEECH RECEPTION TECHNIQUE

Group		Pretest			Post-Test		
		Right Ear	Left Ear	Free Field	Right Ear	Left Ear	Free Field
Public School	M[a]	9.4	13.8	14.1	6.1	5.6	3.6
	SD[b]	13.6	10.2	14.6	7.7	5.5	6.8
	n[c]	8	8	8	9	9	9
Opportunity Center	M	8.3	8.3	12.2	-0.8	-1.7	-5.0
	SD	15.5	9.4	6.8	8.9	6.2	7.1
	n	6	6	6	6	6	6
State School	M	5.6	7.5	10.9	3.9	4.4	3.0
	SD	5.8	8.3	10.1	7.0	5.0	5.0
	n	8	8	8	9	9	9
Non-Mongoloid With Neurological Defect	M	5.4	10.0	9.9	1.1	0.4	-1.7
	SD	10.3	6.5	10.8	9.3	6.2	8.5
	n	12	12	12	14	14	14
Mongoloid with No Neurological Defect	M	17.0	14.0	21.6	8.3	7.5	4.2
	SD	15.4	9.5	12.9	7.5	6.3	7.9
	n	5	5	5	6	6	6
Mongoloid with Neurological Defect	M	5.0	12.5	10.2	2.5	3.8	1.3
	SD	7.0	7.5	2.9	7.5	8.2	7.4
	n	4	4	4	4	4	4
Total Group	M	8.6	10.0	12.4	3.3	3.8	1.2
	SD	10.5	9.8	11.4	8.3	6.7	7.2
	n	22	22	22	24	24	24

[a] Mean hearing level in decibels.

[b] Standard deviation in decibels.

[c] Number of ears monaurally of subjects in free field.

responded to the pretest of this technique than to the pretests of the pure-tone threshold acuity techniques. The children found the speech a more meaningful stimulus than the pure tones.

On both the pretest and the post-test, the Public School Group had the highest mean hearing level of the three school groups. On the pretest, the Public School Group also had the highest standard deviation of the three school groups. For the neurological groups, the Mongoloid with No Neurological Defect Group had the highest mean hearing level and the largest standard deviation.

On the post-test of the speech reception technique, the Opportunity Center Group had the lowest mean hearing level and the largest standard deviation of the school groups. In the neurological groups, the Non-Mongoloid with Neurological Defect Group had the lowest mean hearing level in two out of three cases and the highest standard deviation. The Mongoloid with No Neurological Defect Group had the highest mean hearing level.

The pretest mean hearing levels for the school groups on the free field tests were higher than the monaural hearing levels, but this was not true for the neurological groups where the mean hearing levels of the left ear were the highest levels in two out of three cases. The differences between the pretest and the post-test free field mean hearing levels were large. In the case of the Opportunity Center Group, the difference was 17.2 decibels.

For the total group, all of the post-test mean hearing levels were lower than the pretest mean hearing levels. The post-test standard deviations were smaller than the pretest standard deviations.

The children in all of the groups showed great improvement from the pretest to the post-test in their ability to respond to this technique at lower intensity levels with less variability. All of the mean hearing levels on the post-test are within the range of normal hearing.

The Wilcoxon Matched-Pairs Signed-Ranks test was used to test the significance of the differences between the pretest and the post-test thresholds on the modified speech reception test. When the total group differences were considered, the left ear differences were significant at the .05 level and the free field differences were significant at the .01 level. The right ear differences did not reach significance at the .05 level. When the significance of the differences between the pretest and the post-test thresholds of the three school groups on the speech reception test was computed, only one--the free field test difference for the State School Group--reached significance at the .05 level. When the significance of the differences between the pretest and the post-test thresholds of the three neurological groups was computed, the free field test for the Non-Mongoloid with Neurological Defect Group reached significance at the .05 level. None of the other tests with the neurological groups reached significance at the .05 level.

The Median test was used to test the significance of the differences of thresholds between the three school groups on the pretest and on the post-test of the speech reception technique. The Public School Group was compared with the Opportunity Center Group, the Opportunity Center Group was compared with the State School Group, and the State School Group was compared with the Public School Group. Nine tests were computed on the pretest and nine tests were computed on the post-test. None of the differences reached significance at the .05 level. The three school groups had about equal auditory acuity as measured by this speech reception test.

The Median test was used to test the significance of the differences of the thresholds between the three neurological groups on the pretest and the post-test of the speech reception technique. The Non-Mongoloid with Neurological Defect Group was compared with the Mongoloid with No Neurological Defect Group, the Mongoloid with No Neurological Defect Group was compared with the Mongoloid with Neurological Defect Group, and the Mongoloid with Neurological Defect Group was compared with the Non-Mongoloid with Neurological Defect Group. Nine tests of significance were computed on the pretest and nine tests on the post-test. None of the tests reached significance at the .05 level. The three neurological groups had about equal auditory acuity as measured by the modified speech reception technique.

The Wilcoxon Matched-Pairs Signed-Ranks test was used to test the significance of the differences of the pretest and the post-test thresholds on the modified speech reception test for the group of children above the mean IQ and the group of children below the mean IQ. For the group of children above the mean IQ, the right ear differences reached significance at the .05 level and the free field differences reached significance at the .01 level. The left ear differences did not reach significance at the .05 level. For the group of children below the mean IQ, the left and right ear differences did not reach significance at the .05 level, but the free field differences reached significance at the .01 level. This indicated that the IQ of the child was related to the amount of difference between the pretest and the post-test threshold with the speech reception test.

Time required for threshold acuity techniques. The data in Table VIII show the mean times and standard deviations required for the audiometric tests. The modified speech reception technique required the least amount of time.

The blinking light technique required the greatest amount of time on both the pretest and the post-test. This was because with this

TABLE VIII

MEAN TIMES AND STANDARD DEVIATIONS IN MINUTES REQUIRED FOR COMPLETION AND TRAINING OF AUDIOMETRIC TESTS

	Time in Minutes									
	Pretest			Post-test			Training			
Group	M[a]	SD[b]	n[c]	M	SD	n	M	SD	n	Audiometric Technique
Public School	33.6	11.5	9	38.9	16.0	9	7.6	5.4	9	Blinking Light
	14.8	5.6	9	19.3	4.4	9	7.2	3.5	9	Ear-choice
	24.6	16.4	9	13.2	2.9	9	6.4	2.1	9	Pediacoumeter
	12.6	4.9	9	8.0	1.8	9	4.2	2.0	9	Speech Reception
Opportunity Center	31.0	13.3	8	36.6	8.0	7	3.5	.5	7	Blinking Light
	15.4	2.8	8	21.4	4.3	9	7.8	3.5	9	Ear-choice
	21.4	9.3	9	15.9	3.6	8	6.5	2.2	8	Pediacoumeter
	12.6	8.4	8	6.2	1.9	6	5.3	4.2	7	Speech Reception
State School	24.9	7.8	9	21.6	6.1	9	2.9	.6	9	Blinking Light
	11.7	3.4	9	16.3	8.3	9	6.6	3.5	9	Ear-choice
	15.4	5.7	9	13.9	4.8	9	5.7	2.0	9	Pediacoumeter
	8.0	1.9	9	4.3	1.1	9	2.4	.5	9	Speech Reception
Non-Mongoloid With Neurological Defect	30.6	12.5	14	31.5	13.3	13	4.4	3.3	13	Blinking Light
	12.1	3.7	14	17.9	4.4	13	7.1	2.9	13	Ear-choice
	16.9	9.3	14	15.2	4.6	13	6.5	2.2	13	Pediacoumeter
	11.3	4.9	14	5.9	3.0	14	4.0	3.4	14	Speech Reception
Mongoloid With no Neurological Defect	29.9	12.2	7	37.8	12.1	6	7.8	5.1	6	Blinking Light
	16.7	3.3	7	21.1	8.1	7	7.0	4.0	7	Ear-choice
	25.6	17.8	7	14.0	11.0	7	5.6	2.1	7	Pediacoumeter
	12.4	8.8	7	5.7	1.6	6	3.2	.9	6	Speech Reception
Mongoloid With Neurological Defect	30.0	5.6	4	23.5	6.1	4	3.3	.8	4	Blinking Light
	-[d]	-	-	19.8	3.8	4	5.0	1.9	4	Ear-choice
	21.8	6.8	4	13.3	2.9	4	5.8	1.5	4	Pediacoumeter
	8.5	1.1	4	5.3	1.6	4	2.5	.9	4	Speech Reception
Total Group	29.8	11.6	26	32.0	15.2	25	5.0	3.9	25	Blinking Light
	13.9	4.5	26	18.6	6.2	25	6.4	4.0	25	Ear-choice
	20.4	12.1	26	14.3	4.0	26	6.2	2.1	26	Pediacoumeter
	10.2	6.1	26	6.2	2.2	25	3.9	2.8	25	Speech Reception

[a] Mean time in minutes.

[b] Standard deviation in minutes.

[c] Number of subjects.

[d] Only one child in this group responded to the pretest.

pure technique, testing was done both monaurally and in the free field while the other pure-tone techniques were done monaurally only. With the blinking light technique, 15 thresholds were obtained and with the other pure-tone techniques, only 10 thresholds were obtained. With the speech reception technique only three thresholds were obtained.

The ear-choice technique required more time on the post-test than on the pretest for all groups. The reason for the small mean time on the pretest was that, while the mean time was computed for all 26 children, only nine of the 26 children completed the pretest. The other 17 children did not respond to the test and less time was spent with the children who did not respond than with the children who did respond. On the post-test, most of the children completed the test and required more time.

The technique with the Pediacoumeter required less time on the post-test than on the pretest. However, if the mean training time is added to the mean post-test time, then the Opportunity Center Group, the State School Group, and the Non-Mongoloid with Neurological Defect Group required slightly more time for the post-test than for the pretest.

The speech reception test required less time on the post-test than on the pretest. Again, however, if the mean training time is added to the mean test completion time, the times are almost equal.

In testing the auditory acuity of these trainable mentally retarded children, time was a very important factor. These children had a short attention span and it was necessary to complete each test as quickly as possible. If time were the only criterion for selection of an audiometric technique to use with trainable mentally retarded children, then the modified speech reception would be the technique selected.

Intertest differences of threshold acuity tests. The Wilcoxon Matched-Pairs Signed-Ranks test was used to test the significance of the differences between the thresholds between the blinking light technique, the ear-choice technique, and the technique with the Pediacoumeter. A test was computed for each of the five frequencies in the right ear and in the left ear on both the pretest and the post-test.

Ten tests were computed to test the significance of the differences of the thresholds between the pretests of the blinking light technique and the ear-choice technique. None of the differences reached significance at the .05 level.

Ten tests were computed to test the significance of the differences between the pretest thresholds of the blinking light technique and the technique with the Pediacoumeter. None of the ten tests reached significance at the .05 level.

Only two tests could be computed to test the significance of the differences of the thresholds between the pretests of the ear-choice technique and the Pediacoumeter. Neither test reached significance at the .05 level.

Ten tests were computed to test the significance of the differences between the post-test thresholds of the blinking light technique and the ear-choice technique. Eight of the ten tests reached significance at the .01 level, and the other two tests did not reach significance at the .05 level. The direction of the differences was for lower thresholds on the blinking light technique.

Ten tests of significance were computed between the post-test thresholds of the blinking light technique and the technique with the Pediacoumeter. None of the ten tests reached significance at the .05 level. The direction of the differences was for lower thresholds on the blinking light technique.

Ten tests of significance were computed to test the significance of the differences between the post-test thresholds of the ear-choice technique and the technique with the Pediacoumeter. Four of the 10 tests reached significance at the .05 level and five tests reached significance at the .01 level. Only one test failed to reach significance. The direction of the differences was for better hearing on the technique with the Pediacoumeter than was shown by the ear-choice technique.

The results showed that there was little difference between the three pure-tone threshold acuity techniques on the pretests. On the post-tests, however, both the blinking light technique and the technique with the Pediacoumeter were significantly different from the ear-choice technique. On the post-tests, there were no significant differences between the blinking light technique and the technique with the Pediacoumeter. The blinking light technique and the technique with the Pediacoumeter were more closely related to each other than they were to the ear-choice technique.

The Wilcoxon Matched-Pairs Signed-Ranks test was used to test the significance of the differences between the best binaural average (BBA) of the blinking light technique, the ear-choice technique, and the technique with the Pediacoumeter with the free field threshold of the modified speech reception technique. Also, the average of 500 cps, 1000 cps, and 2000 cps for each of the three pure tone techniques on the right ear and the left ear was computed. The right ear average was tested with the right ear threshold on the modified speech reception test, and the left ear average was tested with the left ear threshold on the modified speech reception test. Tests were computed for both pretest and post-test results.

When the right ear averages and left ear averages on the pretests were compared with the right ear and left ear speech thresholds on the pretests, none of the differences reached significance at the .05 level. When the BBA of the pure-tone techniques was compared with the free field thresholds on speech reception technique, the results for the blinking light technique reached significance at the .05 level, and the results for the ear-choice technique and the technique with the Pediacoumeter reached significance at the .01 level. The post-test results of the tests of significance between the speech reception thresholds and the pure tone results showed that with the blinking light technique and the technique with the Pediacoumeter, there were no differences which reached significance at the .05 level. With the ear-choice technique, however, the differences between the right ear average and the speech reception threshold reached significance at the .05 level. The difference between the pure-tone average and the left ear speech reception threshold was significant at the .01 level as was the difference between the BBA and the free field speech reception threshold.

The results indicated that the post-tests with the blinking light technique and the technique with the Pediacoumeter were more valid than the pretest results. This was indicated by their lack of significant differences with the speech reception results. A post-test following training was worthwhile for all techniques but the ear-choice technique.

PGSR Audiometric Results

PGSR threshold acuity test results. The data in Table IX show the mean thresholds and standard deviations for the total group on the PGSR technique. The number of responses for each frequency shows a range from six to 11. The frequency of 500 cps was the first frequency tested and had the greatest number of responses.

TABLE IX

MEAN HEARING LEVELS OF THE TOTAL GROUP
WITH THE PGSR TECHNIQUE

Frequency in cps	Number of Ears	Mean Hearing Level in db	Standard Deviation
Right Ear:			
250	6	8.7	11.3
500	11	9.9	15.8
1000	9	10.4	17.0
2000	9	7.8	14.9
4000	8	13.3	14.1
Left Ear:			
250	6	12.8	10.0
500	10	9.1	14.2
1000	9	15.7	16.9
2000	8	8.1	13.2
4000	7	9.6	13.1

The mean time required to administer the PGSR threshold acuity technique was 34.4 minutes and the standard deviation was 15.8 minutes. Twenty-five children were administered the PGSR threshold acuity technique.

Because of the small number of children responding, the PGSR results were not divided into school and neurological groups for the computation of mean thresholds, standard deviations, and tests of significance of differences between the thresholds of the groups. The effect of neurological defect on PGSR conditioning was considered. The data in Table X show the effect of neurological defect on conditioning of children to the PGSR.

TABLE X

EFFECT OF NEUROLOGICAL DEFECT ON PGSR CONDITIONING FOR THE PGSR THRESHOLD ACUITY TEST

	Non-Mongoloid With Defect	Mongoloid No Defect	Mongoloid With Defect
Per Cent Conditioned	43	72	50
Per Cent Not Conditioned	50	14	50
Per Cent Emotionally Upset before Conditioning	7	14	0
Per Cent Conditioned who Completed Test	33	43	0
Number of Children	14	7	4

The Wilcoxon Matched-Pairs Signed-Ranks test was used to test the significance of the differences between the PGSR thresholds and the thresholds of the blinking light technique, the ear-choice technique, and the technique with the Pediacoumeter on both the pretests and the post-tests. Tests of significance were computed for the five frequencies in the right ear and in the left ear.

Ten tests of significance were computed between the PGSR and the pretest of the blinking light technique. None of these tests reached significance at the .05 level. Of the ten tests of significance computed between the PGSR and the pretest of the ear-choice technique, six had a large enough number of scores to compute the significance and only one, the right ear at 500 cps, reached significance at the .05 level. Of the ten tests of significance computed between the PGSR and the pretest with the Pediacoumeter, seven had a large enough number of scores to compute the significance of the differences and none of these reached significance at the .05 level.

Ten tests of significance were computed between the PGSR thresholds and the thresholds on the post-test of the blinking light technique. Two of the ten tests reached significance at the .05 level. They were the 500 cps in the right ear and 1000 cps in the left ear. Ten tests of significance were computed between the PGSR and the post-test of the ear-choice technique, and ten between the PGSR and the post-test with the Pediacoumeter. None of these twenty tests reached significance at the .05 level.

The Wilcoxon Matched-Pairs Signed-Ranks test was computed between the pure-tone average of 500 cps, 1000 cps, and 2000 cps in the right ear and in the left ear of the PGSR test, and the thresholds in the right ear and the left ear of the pretest and the post-test of the modified speech reception test. The free field threshold on the pretest and the post-test of the modified speech reception test was tested with the best binaural average (BBA) of the PGSR test. When the free field threshold on the speech reception test was tested with the best binaural average of the PGSR, neither of the tests on the pretest or the post-test reached significance at the .05 level. When the right ear pure-tone average was tested with the right ear speech reception threshold, neither of the tests on the pretest or the post-test reached significance at the .05 level. However, the left ear pure-tone average and the left ear speech reception threshold tests both reached significance at the .05 level on the pretest and the post-test.

PGSR screening technique. The results of the PGSR screening technique were inconclusive. Of the twenty-four children to whom it was administered, only six children completed the entire test. The mean time required to administer this test to each of the six children was 41.3 minutes.

The data in Table XI show the per cent of each of the neurological groups which conditioned to this test. The per cent of each group which became emotionally upset before conditioning ~~was~~ established was higher on the screening technique than it was on the PGSR threshold acuity technique (Table X). This may have been due to the children's remembering that shock was used on the threshold acuity test and this created anxiety when the screening technique was tried.

TABLE XI

EFFECT OF NEUROLOGICAL DEFECT ON PGSR CONDITIONING FOR THE PGSR SCREENING TECHNIQUE

	Non-Mongoloid With Defect	Mongoloid No Defect	Mongoloid With Defect
Per Cent Conditioned	50	50	0
Per Cent Not Conditioned	25	33	50
Per Cent Emotionally Upset before Conditioning	25	17	50
Per Cent Conditioned who Completed Test	66	66	--
Number of Children	14	6	4

The criteria used to indicate hearing did not appear valid for use with trainable mentally retarded children. These criteria had been used with "normal" people and were not suitable for use with these children. It was difficult to obtain galvanic responses during the one second to the 7.5 second period following the presentation of the sound. It was difficult to control the movement of the children and this made it difficult to determine if the galvanic responses were the result of the auditory stimuli or the bodily movement of the children. Of the 720 possible responses on the test for the total group, only 231 were recorded because of the failure of the children to condition or because the children became emotionally upset. Of the 231 responses, only 90 were valid responses which met the criteria. This was only 39 per cent. With the criteria which were considered desirable to indicate hearing with this technique, 80 per cent of the responses would have had to have been valid to pass the screening test.

Otometer Screening Techniques

The results of the Otometer screening techniques were compared with the pure-tone threshold acuity techniques to determine the amount of agreement as to the hearing loss of this group of trainable mentally retarded children. The criterion which was used for significant hearing loss with the pure-tone threshold acuity techniques was a loss of more than 20 decibels at any two frequencies in either ear. This criterion was the same as that recommended by the Texas State Department of Health (21). The criterion for not passing the screening techniques was two failures in either ear at the intensity at which the screening was done. This criterion also was recommended by the Texas State Department of Health (21).

The results of each of the threshold acuity techniques were examined to determine the children with significant hearing loss on each technique. The results of the screening techniques also were examined to determine the children with significant hearing loss. Percentages were computed to determine the degree of agreement between the threshold acuity techniques and the Otometer screening techniques.

The agreement between the Otometer screening techniques and the blinking light technique concerning the percentage of significant hearing loss of the trainable mentally retarded children is shown in Table XII. There was more agreement between the screening techniques and the post-tests than between the pretests and the screening techniques. The "Stop Light" technique showed more agreement with the post-tests of the blinking light technique than did the "Car" technique. The post-test blinking light technique and the "Stop Light" technique agreed that 90 per cent of the children had no significant hearing loss, and that five per cent of the children did have significant hearing loss. There was a disagreement of five per cent. The blinking light technique showed this five per cent with a significant hearing loss and the "Stop Light" showed this five per cent with normal hearing.

TABLE XII

COMPARISON OF SIGNIFICANT HEARING LOSS ON THE OTOMETER SCREENING TECHNIQUES AND THE BLINKING LIGHT TECHNIQUE

Otometer Screening Technique	Threshold Acuity Technique		% Sig. Loss	% No Sig. Loss
"Car" at 20 decibels	Pretest, Blinking Light	% Significant Loss	0	0
		% No Significant Loss	14	86
"Car" at 15 decibels	Pretest, Blinking Light	% Significant Loss	0	7
		% No Significant Loss	14	79
"Stop Light" at 20 decibels	Pretest, Blinking Light	% Significant Loss	0	0
		% No Significant Loss	17	83
"Stop Light" at 15 decibels	Pretest, Blinking Light	% Significant Loss	0	0
		% No Significant Loss	17	83
"Car" at 20 decibels	Post-test, Blinking Light	% Significant Loss	5	6
		% No Significant Loss	5	90
"Car" at 15 decibels	Post-test, Blinking Light	% Significant Loss	5	5
		% No Significant Loss	5	85
"Stop Light" at 20 decibels	Post-test, Blinking Light	% Significant Loss	5	0
		% No Significant Loss	5	90
"Stop Light" at 15 decibels	Post-test, Blinking Light	% Significant Loss	5	0
		% No Significant	5	90

The data in Table XIII show the percentage of agreement between the Otometer screening techniques and the ear-choice technique concerning the percentage of significant hearing loss with the trainable mentally retarded children. The Otometer screening techniques showed more agreement with the pretests of the ear-choice technique than with the post-tests. Only a small number of children responded to the pretest of the ear-choice technique while on the post-test most of the children responded. The ear-choice technique showed from 19.5 per cent to 23 per cent of the children with a significant hearing loss, while the Otometer screening techniques showed from five per cent to nine per cent. The disagreement between the ear-choice technique and the screening techniques was large. This disagreement probably reflected the difficulty the trainable mentally retarded children had in responding to the ear-choice technique at low intensity levels.

The data in Table XIV show the agreement as to the percentage of significant hearing loss among the trainable mentally retarded children between the Otometer screening techniques and the technique with the Pediacoumeter. The pretests utilizing the Pediacoumeter and the screening techniques show more agreement than do the post-tests of the Pediacoumeter and the screening techniques. This reflected the smaller number of children who responded to the

TABLE XIII

COMPARISON OF SIGNIFICANT HEARING LOSS ON THE OTOMETER SCREENING TECHNIQUES AND THE EAR-CHOICE TECHNIQUE

Otometer Screening Technique		Threshold Acuity Technique	
		Pretest, Ear-choice	
		% Sig. Loss	% No Sig. Loss
"Car" at 20 decibels	% Significant Loss	0	0
	% No Significant Loss	11	89
		Pretest, Ear-choice	
		% Sig. Loss	% No Sig. Loss
"Car" at 15 decibels	% Significant Loss	0	0
	% No Significant Loss	11	89
		Pretest, Ear-choice	
		% Sig. Loss	% No Sig. Loss
"Stop Light" at 20 decibels	% Significant Loss	0	0
	% No Significant Loss	12.5	87.5
		Pretest, Ear-choice	
		% Sig. Loss	% No Sig. Loss
"Stop Light" at 15 decibels	% Significant Loss	0	0
	% No Significant Loss	12.5	87.5
		Post-test, Ear-choice	
		% Sig. Loss	% No Sig. Loss
"Car" at 20 decibels	% Significant Loss	5	0
	% No Significant Loss	18	77
		Post-test, Ear-choice	
		% Sig. Loss	% No Sig. Loss
"Car" at 15 decibels	% Significant Loss	4.5	4.5
	% No Significant Loss	14	77
		Post-test, Ear-choice	
		% Sig. Loss	% No Sig. Loss
"Stop Light" at 20 decibels	% Significant Loss	5	0
	% No Significant Loss	18	77
		Post-test, Ear-choice	
		% Sig. Loss	% No Sig. Loss
"Stop Light" at 15 decibels	% Significant Loss	5	0
	% No Significant Loss	18	77

TABLE XIV

COMPARISON OF SIGNIFICANT HEARING LOSS ON THE OTOMETER SCREENING TECHNIQUES AND THE TECHNIQUE WITH THE PEDIACOUMETER

Otometer Screening Technique		Threshold Acuity Technique	
		Pretest, Pediacoumeter	
		% Sig. Loss	% No Sig. Loss
"Car" at 20 decibels	% Significant Loss	0	0
	% No Significant Loss	0	100
		Pretest, Pediacoumeter	
		% Sig. Loss	% No Sig. Loss
"Car" at 15 decibels	% Significant Loss	0	7
	% No Significant Loss	0	93
		Pretest, Pediacoumeter	
		% Sig. Loss	% No Sig. Loss
"Stop Light" at 20 decibels	% Significant Loss	0	0
	% No Significant Loss	0	100
		Pretest, Pediacoumeter	
		% Sig. Loss	% No Sig. Loss
"Stop Light" at 15 decibels	% Significant Loss	0	0
	% No Significant Loss	0	100
		Post-test, Pediacoumeter	
		% Sig. Loss	% No Sig. Loss
"Car" at 20 decibels	% Significant Loss	4.3	0
	% No Significant Loss	4.3	91.3
		Post-test, Pediacoumeter	
		% Sig. Loss	% No Sig. Loss
"Car" at 15 decibels	% Significant Loss	4.3	4.3
	% No Significant Loss	4.3	87
		Post-test, Pediacoumeter	
		% Sig. Loss	% No Sig. Loss
"Stop Light" at 20 decibels	% Significant Loss	5	0
	% No Significant Loss	5	90
		Post-test, Pediacoumeter	
		% Sig. Loss	% No Sig. Loss
"Stop Light" at 15 decibels	% Significant Loss	5	0
	% No Significant Loss	5	90

pretest as compared with the post-test of the Pediacoumeter. Many of the children who responded to the post-test did not respond to the pretest, and responded at a high intensity level on the post-test.

The Otometer screening techniques showed that about five per cent of the trainable mentally retarded children in this study had a significant hearing loss. The post-tests with the Pediacoumeter and the blinking light technique showed about 10 per cent of the children had a significant hearing loss. The true incidence of significant hearing loss for the sample of children used in this study probably is somewhere between five per cent and ten per cent.

Because the two Otometer screening techniques were designed for this study, an attempt was made to validate these two techniques on a group of nursery school children. Ninety-five nursery school children between the ages of three and five were tested at The University of Texas Nursery School and All Saint's Episcopal Nursery School. Fifty-one of the children were tested with the Otometer "Car" technique and 44 were tested with the Otometer "Stop Light" technique. All testing was done at the nursery schools and at a hearing loss dial setting of 20 decibels. A 20 decibel hearing loss dial setting was used rather than a 15 decibel hearing loss dial setting because of the noise level in the school buildings where the testing was done.

When the screening techniques with the Otometer were finished, a retest was made of 46 of the nursery school children with a Beltone Model 11-A Audiometer. The children were given a sweep check of hearing at 20 decibels. The children were asked to hold up their hands when they heard the sound and to put the hand down when they did not hear the sound any longer. The purpose of this retest was to see if a conventional audiometric technique which has been proven by years of usage would detect any hearing loss which the Otometer techniques did not detect. The results are shown in Table XV.

TABLE XV

AGREEMENT BETWEEN OTOMETER TECHNIQUES AND SWEEP CHECK TECHNIQUE ON NURSERY SCHOOL CHILDREN

Test	Number Tested	Number Passing	Number Failing
Otometer Car	27	27	0
Sweep Check	27	27	0[a]
Otometer Stop Light	19	19	0
Sweep Check	19	19	0[b]

[a] Two children failed the sweep check the first time but passed a recheck.

[b] One child failed the sweep check the first time but passed a recheck.

The data in Table XV showed that the Otometer screening techniques gave the same results as the conventional sweep check test. The sample used, however, was small and a much larger sample would be necessary before more definite conclusions could be reached regarding the validity of the Otometer screening techniques.

Other Results of the Study

The trainable mentally retarded children in this study showed a wide variation in their ability to perform the different audiometric tests. Most of the children performed successfully the post-tests and the screening techniques with the Otometer. Most of the children successfully completed the modified speech reception test on both the pretest and the post-test. The three techniques to which many of the children did not respond on the pretest were the blinking light technique, the ear-choice technique, and the technique with the Pediacoumeter. An attempt was made to determine if there were any significant correlation between the MA, CA, and IQ of the children and the successful completion of the three pretests. The children were divided into groups which were above the means and below the means of the CA, MA, and IQ. The number of children who completed and did not complete each of the three pretests was computed for each group above and below the mean CA, MA, and IQ. The results were placed in a 2 x 2 contingency table and phi coefficients were computed.

When the children were divided into groups above and below the mean CA and the number computed showing how many of each group completed and did not complete the pretests of the three audiometric techniques, none of the phi coefficients reached significance at the .05 level. The phi coefficients ranged from .01 for the blinking light technique to .20 for the ear-choice technique.

When the children were divided into groups above and below the mean IQ and the number computed showing how many of each group completed and did not complete the three pretests, none of the phi coefficients reached significance at the .05 level. The phi coefficients ranged from .04 for the technique with the Pediacoumeter to .21 for the blinking light technique.

When the children were divided into groups above and below the mean MA, none of the phi coefficients reached significance at the .05 level. The phi coefficients ranged from .03 for the ear-choice technique to .26 for both the blinking light technique and the Pediacoumeter.

The results indicated that the CA, MA, and IQ are not good predictors of the ability of trainable mentally retarded children to perform pure-tone audiometric tests. The ability of most of the children to perform the post-tests indicated that most trainable mentally retarded children can be trained, either by a training period or by repeated audiometric tests, to give a satisfactory performance on an audiometric test.

Rank correlation coefficients were computed between the CA, MA, and IQ, and the time required for audiometric testing on the pre-tests and post-tests of the blinking light technique, the ear-choice technique, the modified speech reception technique, and the technique with the Pediacoumeter. The ranking was done from the largest to the smallest. The larger the negative correlation coefficient, in this instance, the more correlation there was between the two factors which were ranked.

The data in Table XVI show the rank correlation coefficients between the CA and the time required to complete the test when both were ranked. None of the rank correlation coefficients reached significance at the .05 level.

The data in Table XVII show the rank correlation coefficients between the IQ and the time required to complete the audiometric tests. One of the eight coefficients reached significance at the .01 level, and one reached significance at the .02 level.

The data in Table XVIII show the rank correlation coefficients between the MA and the time required to complete the audiometric tests. The audiometric test which showed the greatest correlation with the MA was the blinking light test.

TABLE XVI

RANK CORRELATION COEFFICIENTS BETWEEN CA AND TIME TO COMPLETE TEST

Test	r'[a]	df[b]	Significance Level
Pretest--Blinking Light	-.501	13	NS[c]
Post-test--Blinking Light	-.263	19	NS
Pretest--Ear-choice	-.180	7	NS
Post-test--Ear-choice	.008	22	NS
Pretest--Pediacoumeter	-.416	13	NS
Post-test--Pediacoumeter	-.233	23	NS
Pretest--Speech Reception	-.204	20	NS
Post-test--Speech Reception	-.156	22	NS

[a] r'--rank correlation coefficient

[b] df--degrees of freedom

[c] NS--Not significant

TABLE XVII

RANK CORRELATION COEFFICIENTS BETWEEN IQ AND TIME TO COMPLETE TEST

Test	r'[a]	df[b]	Significance Level
Pretest--Blinking Light	-.498	13	NS[c]
Post-test--Blinking Light	-.565	19	.01
Pretest--Ear-choice	.177	7	NS
Post-test--Ear-choice	-.516	21	.02
Pretest--Pediacoumeter	-.233	13	NS
Post-test--Pediacoumeter	-.199	23	NS
Pretest--Speech Reception	-.122	20	NS
Post-test--Speech Reception	-.336	22	NS

[a] r'--rank correlation coefficient

[b] df--degrees of freedom

[c] NS--Not significant

TABLE XVIII

RANK CORRELATION COEFFICIENTS BETWEEN MA AND TIME TO COMPLETE TEST

Test	r'[a]	df[b]	Significance Level
Pretest--Blinking Light	-.738	13	.01
Post-test--Blinking Light	-.723	19	.01
Pretest--Ear-choice	.055	7	NS[c]
Post-test--Ear-choice	-.411	22	.05
Pretest--Pediacoumeter	-.507	13	NS
Post-test--Pediacoumeter	-.268	23	NS
Pretest--Speech Reception	-.259	20	NS
Post-test--Speech Reception	-.506	22	.02

[a] r'--rank correlation coefficient

[b] df--degrees of freedom

[c] NS--Not significant

The rank correlation coefficients indicated that there was more correlation between the MA and the time required to complete audiometric tests than between CA and IQ and the required time. Also, only with the blinking light technique can the MA be used to estimate the amount of time which is required for a trainable mentally retarded child to complete an audiometric test on both a pretest and on a post-test.

CHAPTER V

SUMMARY AND CONCLUSIONS

Summary

The purpose of this study was to evaluate and structure techniques for testing the auditory acuity of trainable mentally retarded children. A group of trainable mentally retarded children was given an extensive series of audiometric tests consisting of pure-tone threshold acuity techniques, PGSR audiometry, modified speech reception, and screening techniques.

The sample population of the study consisted of 26 trainable mentally retarded children. The children were in classes for the trainable mentally retarded at a public school, the Austin Opportunity Center, and the Austin State School. Psychological evaluations and extensive medical baseline data were available for each child. The neurologist classified the children into four neurological groups on the basis of his neurological examination and all of the other medical data. The four neurological groups were: (1) the Non-Mongoloid with No Neurological Defect Group; (2) the Non-Mongoloid with Neurological Defect Group; (3) the Mongoloid with No Neurological Defect Group; and (4) the Mongoloid with Neurological Defect Group. One group, the Non-Mongoloid with No Neurological Defect, had only one child and this group was not used in the statistical analysis of the study.

Summary of threshold acuity techniques. Three pure-tone threshold acuity techniques were used: the blinking light technique, the ear-choice technique, and the technique with the Pediacoumeter. Also, a modified speech reception test was used. With each of the four techniques, the children were given a pretest and a post-test. The children received no training before the pretest. Before the post-test, the children were given a training period. For the pure-tone techniques, recorded music was used to train the children to listen to sound. For the speech reception technique, the training consisted of teaching the children the names of the toys used in the test.

In the statistical analysis of the pure-tone techniques, each frequency was considered separately for each ear and in the free field. The following frequencies were tested: 250 cps, 500 cps, 1000 cps, 2000 cps, and 4000 cps. With the speech reception technique, the right ear, the left ear, and the free field thresholds were considered separately.

The 26 children were considered as a total group and mean thresholds and standard deviations were computed. Tests of the significance of the differences between the pretest and the post-test thresholds were computed for each of the techniques. The Wilcoxon Matched-Pairs Signed-Ranks test was used for this purpose.

Another analysis of the data was made according to the school groups. The children in the Public School Group, the Opportunity Center Group, and the State School Group were considered separately and mean thresholds and standard deviations on each of the techniques for each of the groups were computed. The Wilcoxon Matched-Pairs Signed-Ranks test was used to test the significance of the differences between the pretest and the post-test thresholds on each of the techniques for each school group. The Median test was used to test the significance of the differences of the thresholds of each of the school groups on both the pretest and the post-test of the four techniques. This was done to see if there were any significant differences in the hearing acuity of the three school groups.

Also, an analysis was made of the data according to the neurological classification of the children. Mean thresholds and standard deviations of each of the techniques for each of the neurological groups were computed. The Wilcoxon Matched-Pairs Signed-Ranks test was used to test the significance of the differences between the pretest and post-test thresholds of each of the techniques for the neurological groups. The Median test was used to compute the significance of the differences of the thresholds between the neurological groups on each of the techniques.

The results obtained from the total group showed that the significance of the differences between the pretest and post-test thresholds varied with the audiometric technique used. The thresholds on the post-tests were significantly different from the pretest thresholds with the blinking light technique, the technique with the Pediacoumeter, and the modified speech reception technique. There were no significant differences between the pretest and post-test thresholds with the ear-choice technique. The results showed the importance of a sequence of testing by a pretest and then a post-test. Also, it was shown that audiometric techniques do vary in the pure-tone thresholds obtained with them.

When the significance of the differences between the pretest and the post-test thresholds for the school groups was computed, the results varied with the audiometric technique used. With the blinking light technique, the State School Group showed significant differences between the pretest and post-test thresholds while the Opportunity Center Group and the Public School Group did not show significant differences. The response of the Public School Group on the pretest of the blinking light technique was very small and in most cases it was not possible to compute the significance of the differences. Because of the small number of responses from the school groups on the ear-choice technique, it was not possible to compute the significance of the differences between the pretest and the post-test thresholds. With the technique using the Pediacoumeter, none of the school groups showed significant differences which reached the .05 level between the pretest and the post-test thresholds. The small number of responses on the pretest made it difficult for the school groups to show any significant change in threshold. With the speech reception technique, the Public School Group and the Opportunity Center Groups did not show a significant change in thresholds between the pretest and the post-test. The State School Group showed significant changes in thresholds on the free field test.

When the significance of the differences between the pretest and post-test thresholds was computed for the neurological groups, the results varied with the audiometric technique. With the blinking light technique, the Non-Mongoloid with Neurological Defect Group showed significant differences between pretest and post-test thresholds. The small number of responses by the Mongoloid with No Neurological Defect and the Mongoloid with Neurological Defect Groups made it impossible to compute the Wilcoxon Matched-Pairs Signed-Ranks test. With the ear-choice technique, the Mongoloid with Neurological Defect Group did not have enough responses to compute the significance of the differences. For the Non-Mongoloid with Neurological Defect Group and the Mongoloid with No Neurological Defect Group, none of the differences of thresholds reached significance at the .05 level but this was due to small numbers which made it impossible to reach the desired level of significance. With the technique using the Pediacoumeter, neither the Mongoloid with No Neurological Defect Group nor the Mongoloid with Neurological Defect Group had a large enough number of responses to compute the Wilcoxon Matched-Pairs Signed-Ranks test. For the Non-Mongoloid with Neurological Defect Group, none of the tests reached significance at the .05 level. With the modified speech reception test, the Mongoloid with No Neurological Defect Group and the Mongoloid with Neurological Defect Group did not have a large enough number of responses to compute the Wilcoxon Matched-Pairs Signed-Ranks test. The Non-Mongoloid with Neurological Defect Group showed significant differences between pretest and post-test thresholds for the free field test, but did not show significant differences monaurally.

The significance of the differences between the thresholds of the three school groups were computed on the pretest and the post-test. The results varied with the audiometric technique. With the post-test of the blinking light technique, some of the differences in thresholds between the State School Group and the Public School Group reached significance at the .05 level. With the ear-choice technique, the technique using the Pediacoumeter, and the modified speech reception technique, none of the differences of thresholds between the three school groups reached significance at the .05 level either on the pretest or the post-test. The groups varied little in auditory acuity.

The significance of the differences between the thresholds of the three neurological groups was computed on the pretest and the post-test. On both the pretests and the post-tests, the auditory acuity of the three neurological groups showed no significant differences.

The significance of the differences of the thresholds obtained on the pretests of the blinking light technique, the ear-choice technique, and the technique using the Pediacoumeter was computed. None of the pretest differences between the three pure-tone techniques reached significance at the .05 level. On the post-tests of the three pure-tone techniques, differences which were significant at the .05 level were found. The post-test thresholds with the blinking light technique and the technique using the Pediacoumeter were significantly different from the post-test thresholds obtained with the ear-choice technique.

The significance of the differences between the thresholds on the speech reception test and the average of the 500 cps, 1000 cps, and 2000 cps thresholds in each ear was computed for the pretests and the post-tests. On the pretests of the blinking light technique, the ear-choice technique, and the technique using the Pediacoumeter, the average of the 500 cps, 1000 cps, and 2000 cps thresholds did not differ significantly from the modified speech reception threshold for the same ear. On the post-tests, the average of the 500 cps, 1000 cps, and 2000 cps did not differ significantly from the speech reception thresholds for the blinking light technique and the technique using the Pediacoumeter. However, the pure-tone average on the ear-choice technique and the speech reception threshold for the same ear did differ significantly.

Summary of PGSR techniques. The PGSR threshold acuity technique was used in this study. Mean thresholds and standard deviations were computed for each frequency and each ear for the total group.

Tests of significance were computed between the PGSR thresholds and the thresholds obtained on the blinking light technique, the ear-choice technique, and the technique using the Pediacoumeter. On the pretests of the technique using the Pediacoumeter and the blinking light technique, the thresholds did not differ at the .05 level of significance. There was a difference which was significant at the .05 level between the pretest of the ear-choice technique and the PGSR thresholds. Some of the post-test thresholds of the blinking light technique and the PGSR thresholds did show a difference which was significant at the .05 level. There were no differences which reached significance at the .05 level between the post-test thresholds of the ear-choice technique and the technique using the Pediacoumeter when they were compared with the PGSR thresholds.

A PGSR screening technique was attempted. The problems of emotional upset and the failure of the children to condition to the PGSR were not overcome. This technique was not successful in screening for hearing loss with this group of trainable mentally retarded children.

Summary of Otometer screening techniques. Two techniques were developed for screening trainable mentally retarded children for hearing loss. One of the screening techniques used a toy "car" with the Otometer and the other screening technique used a "stop light" with the Otometer. Both of these techniques showed agreement with the post-tests of the blinking light technique, the ear-choice technique, and the technique using the Pediacoumeter that from five per cent to 10 per cent of the trainable mentally retarded children in this study had a significant hearing loss. The Otometer screening techniques need to be used with a large sample to establish their validity.

Summary of other results of the study. The children were divided into groups above and below the means of the CA, MA, and IQ. Phi coefficients were computed to find the correlation between being above and below the mean on CA, MA, and IQ and the successful or unsuccessful completion of the pretest of the blinking light technique, the ear-choice technique, and the technique using the Pediacoumeter. None of the phi coefficients reached significance at the .05 level. With this group of trainable mentally retarded children, there was no significant correlation between being above or below the mean CA, MA, or IQ and the successful completion of the pretests.

Rank correlation coefficients were computed between the CA and the time required for the child to complete the pretest and the post-test of the blinking light technique, the ear-choice technique, the speech reception technique, and the technique using the Pediacoumeter. None of the rank correlation coefficients reached significance at the .05 level on either the pretests or the post-tests.

Rank correlation coefficients were computed between the IQ and the time the children required to complete the pretest and the post-test of the blinking light technique, the ear-choice technique, the speech reception technique, and the technique using the Pediacoumeter. Two of the eight rank correlation coefficients reached significance. They were the post-tests of the ear-choice technique and the blinking light technique.

Rank correlation coefficients were computed between the MA and the time the children required to complete the pretest and the post-test of the blinking light technique, the ear-choice technique, the speech reception technique, and the technique using the Pediacoumeter.

The rank correlation coefficient and the time required for the blinking light technique and the MA reached significance at the .01 level on both the pretest and the post-test. The rank correlation coefficient between the MA and the time required to complete the ear-choice technique did not reach significance at the .05 level on the pretest, but was significant at the .05 level on the post-test. The rank correlation coefficient between the MA and the time required to complete the technique using the Pediacoumeter did not reach significance at the .05 level on either the pretest or the post-test. The rank correlation coefficients which were computed between the MA and the time required to complete the modified speech reception technique did not reach significance at the .05 level on the pretest, but was significant at the .02 level on the post-test.

Conclusions

The following are the conclusions about each of the major hypotheses:

Hypothesis one: "There are no significant differences between the pretest and post-test thresholds of the pure-tone threshold acuity techniques."

This hypothesis was rejected for the blinking light technique. When the significance of the differences of thresholds between the pretest and post-test for the total group were computed, 12 of the 15 tests which were computed showed significant differences.

The hypothesis was not rejected for the ear-choice technique. There were no instances where the differences reached significance at the .05 level.

The hypothesis was rejected for the technique using the Pediacoumeter. When the total group was considered, one test reached significance at the .01 level.

The results of this hypothesis were important because it was shown that there were significant changes in the auditory thresholds of trainable mentally retarded children when the children were given a post-test following training and listening experience. Also, it was shown that there are differences in the amount of change from a pretest to a post-test from one audiometric technique to another.

Hypothesis two: "There are no significant differences between the pretest and post-test thresholds on the modified speech reception test."

This hypothesis was rejected. On the tests of the significance of the differences for the total group, the left ear differences reached significance at the .05 level, and the free field differences reached significance at the .01 level.

The results showed that the trainable mentally retarded children responded at significantly lower levels of intensity on the post-test than they did on the pretest. Even though more children responded to the pretest of the speech reception test than to the pretest of any other threshold acuity technique, sufficient learning took place from pretest to post-test to justify the post-test with this technique.

Hypothesis three: "There are no significant differences between the thresholds of the three school groups."

This hypothesis was tested with the blinking light technique, the ear-choice technique, the modified speech reception technique, and the technique using the Pediacoumeter. When the hypothesis was tested with the ear-choice technique, the modified speech reception technique, and the technique with the Pediacoumeter, the hypothesis was not rejected. With the blinking light technique, the hypothesis was rejected as significant differences were found between the Public School Group and the State School Group. This showed that the significance of the differences between the hearing acuity of the three groups varied with the audiometric technique. Only the blinking light technique was sensitive enough to detect the intergroup differences.

Hypothesis four: "There are no significant differences between the thresholds of the three neurological groups."

This hypothesis was not rejected. None of the audiometric techniques showed any significant differences. As far as this study could detect, neurological involvement had no significant relationship to hearing threshold.

Hypothesis five: "There are no significant differences between the thresholds obtained on the three pure-tone threshold acuity techniques (the blinking light, the ear-choice, and the Pediacoumeter)."

The hypothesis was not rejected for the pretests of the three techniques. On the post-tests, however, both the blinking light technique and the technique using the Pediacoumeter were statistically different from the ear-choice technique, but there were no significant differences between them. Since the three techniques do not differ significantly on the pretest, any one of the techniques would be equally good for testing the auditory acuity of trainable mentally retarded children if only one test is used. However, if a follow-up test is planned, then either the blinking light technique or the technique with the Pediacoumeter should be used.

Hypothesis six: "There are no significant differences between the thresholds on the blinking light technique, the ear-choice technique, and the technique with the Pediacoumeter, and the thresholds obtained on the PGSR threshold acuity technique."

With the technique using the Pediacoumeter, the hypothesis was not rejected. There were no significant differences which reached the .05 level on either the pretest or the post-test. There were significant differences between the post-test of the blinking light technique and the PGSR thresholds. The pretest of the ear-choice technique and the PGSR thresholds had significant differences at the .05 level. The hypothesis was rejected for the pretest of the ear-choice technique and the post-test of the blinking light technique.

The results showed that the relationship of the PGSR to other threshold acuity techniques varied. The PGSR measured the auditory acuity of the children as well as the Pediacoumeter even though the children found the Pediacoumeter a much more enjoyable experience and a much larger number of the children responded to the Pediacoumeter than responded to the PGSR technique.

Hypothesis seven: "There are no significant differences between the average of the thresholds of 500 cps, 1000 cps, and 2000 cps of each ear and the modified speech reception threshold for that ear."

The hypothesis was not rejected for the blinking light technique and the technique using the Pediacoumeter. The ear-choice technique average on the post-test showed significant differences from the speech reception threshold, so the hypothesis was rejected for the post-tests of the ear-choice technique. The indication was that the pure-tone techniques, with the exception of the ear-choice technique, were measuring the same auditory function as the modified speech reception technique.

Hypothesis eight: "There are no significant differences between the free field thresholds on the modified speech reception technique and the best binaural averages of the pure-tone threshold acuity techniques."

The hypothesis was not rejected for the best binaural average of the PGSR and the free field thresholds on the pretest and the post-test of the speech reception technique. No significant differences were found.

The hypothesis was rejected for the pretests of the blinking light technique, the ear-choice technique, and the technique using the Pediacoumeter. On the post-tests of the blinking light technique and the technique using the Pediacoumeter, the best binaural averages did not differ significantly from the free field speech reception thresholds and the hypothesis was not rejected. The best binaural averages of the post-test of the ear-choice technique did differ significantly from the post-test free field threshold on the speech reception technique and the hypothesis was rejected.

The post-test threshold averages were closely related to the free field speech reception thresholds. This indicated that with training and listening experience the best binaural average was a better predictor of speech threshold level than the pretest best binaural average.

Hypothesis nine: "The time required to administer an audiometric test is not correlated significantly with the CA, MA, or IQ of the trainable mentally retarded child."

No significant correlation was found between the CA and the time required to administer an audiometric test and the hypothesis was not rejected. Significant correlation was found between the time required to administer an audiometric test and both the MA and the IQ and the hypothesis was rejected. This indicated that the CA of a child was not a good guide in predicting the time a child should take to complete an audiometric test. The child performed more in accordance with his IQ and MA.

Conclusions other than those related to the major hypotheses were reached as a result of this study:

The validity of the pure-tone threshold acuity techniques. The term "validity" was used to mean validity in the practical sense. Did these pure-tone threshold acuity techniques measure hearing acuity? The validity was inferred from the interrelationships of the various tests. On the pretests, the blinking light technique, the ear-choice technique, and the technique using the Pediacoumeter had no significant differences in thresholds. On the post-tests, there were significant differences when the ear-choice thresholds were compared with the thresholds of the blinking light technique and the technique using the Pediacoumeter.

The validity of the pure-tone results was inferred also from the relationship of the pure-tone results to the speech reception results. Harris (41) stated that the relationship of the 500 cps, 1000 cps, and 2000 cps average to the speech reception thresholds was a straight line function. When the pretest average of the 500 cps, 1000 cps, and 2000 cps for each ear on the blinking light technique, the ear-choice technique, and the technique using the Pediacoumeter was compared with the pretest speech reception threshold for the same ear, no significant differences were found. On the post-test with the blinking light technique and the technique using the Pediacoumeter, no significant differences were found. On the post-test of the ear-choice technique, however, significant differences were found between the pure-tone average and the speech reception thresholds.

The technique using the Pediacoumeter and the blinking light technique appeared to have more validity than the ear-choice technique. They maintained a more constant relationship with each other and with the thresholds of the modified speech reception test.

The use of PGSR with trainable mentally retarded children. It was a conclusion of this study that psychogalvanic skin response audiometry was not a satisfactory technique to use with trainable mentally retarded children. The problem of conditioning the children to the PGSR was great. Another great problem was the emotional upsets which the children had during the use of PGSR. Even though the minimal amount of shock was used, the children found it very upsetting. On the PGSR threshold acuity technique, less than half of the children who conditioned to the test finished the test. On the PGSR screening technique, which was done after the PGSR threshold acuity technique, emotional upsets were even greater, although more of the children who conditioned to the test completed the test.

More elaborate instrumentation might make it possible to establish more conditioning in a group of trainable mentally retarded children, but the problem of emotional upsets would still be a great one. The rapport which had been established with the group of children used in this study was very good, but it was not sufficient to overcome the problems involved in using the PGSR techniques. The other audiometric techniques were pleasant experiences for the mentally retarded children while the PGSR techniques were unpleasant experiences. If the PGSR is tried with trainable mentally retarded children, probably it should be tried only when all other techniques have failed.

The Otometer screening techniques. Any conclusions regarding the results of the Otometer screening techniques must be considered as tentative. The screening technique results showed perfect agreement with the sweep check test on the "normal" nursery school children.

With the trainable mentally retarded children, the Otometer screening technique results showed the greatest amount of agreement with the technique using the Pediacoumeter, and the least amount of agreement with the ear-choice technique. Before these techniques can be considered valid for use with trainable mentally retarded children, they must be used with a large sample of children. Also, the children in this study had had considerable listening experience when they were screened with these techniques, which may have affected the performance and the results of these children.

The effect of training on post-test results. No positive conclusions could be reached concerning the effect of training on the ability of the children to respond to the post-test. Because of the small sample available, no control was established which did not receive the training. The children did receive intensive auditory testing and this experience alone may have been enough without any training. However, it was found that the training with music provided a very pleasant experience for the children and it may have been responsible for bringing forth better responses on the post-tests in which it was used.

Groups above and below the mean IQ. The children were divided into groups above and below the mean IQ to attempt to determine which group showed the most significant differences between the pretest and post-thresholds. With the ear-choice technique, neither group made any changes in thresholds which reached significance at the .05 level. Also, neither group made any changes in thresholds which reached significance at the .05 level with the technique using the Pediacoumeter. With the blinking light technique, the group below the mean IQ made more significant changes in threshold than did the group above the mean IQ. With the modified speech reception technique, the group above the mean IQ made more significant changes in threshold than did the group below the mean IQ.

Recommendations for audiometric techniques. The usefulness of the various audiometric techniques used in this study will depend on the purposes of the audiometric testing. If the purposes of the testing can be met by pure-tone screening techniques, then the Otometer screening techniques are an easy technique to use with trainable mentally retarded children. The children used in this study responded to the Otometer screening techniques readily without any training. Since the Otometer screening techniques were individual screening techniques, the tester was able to judge the responses of each child individually and to make a decision as to their validity.

If a pure-tone screening test is not sufficient for the purposes of the testing and more diagnostic information is wanted concerning the auditory acuity of a trainable mentally retarded child, the blinking light technique can be used. The thresholds secured by this technique showed significant change from the pretest to the post-test. The intellectual demands of this test appeared to be less than for the ear-choice technique and the technique using the Pediacoumeter. With the ear-choice technique, the child not only had to decide if the sound was heard, but also he had to decide in which ear the sounds was heard. In the technique using the Pediacoumeter, the child had to decide if the sound was heard and then he had to push a button. In the blinking light technique, thechild only had to decide if the sound was heard and then turn his head so he could see the light. The blinking light technique is the best pure-tone threshold acuity technique to use with trainable mentally retarded children. The technique with the Pediacoumeter is the next best technique. The ear-choice technique is difficult for use with the trainable mentally retarded. The PGSR threshold acuity technique is not recommended for use with these children.

The modified speech reception technique is recommended for use with trainable mentally retarded children. More children responded to the pretest of this technique than to the pretest of any other technique. This indicated that this techniquewas meaningful to these children. This technique would be very useful if the only purpose of the testing is to obtain a good estimate of the auditory acuity of trainable mentally retarded children. The modified speech reception technique, however, does not give as much diagnostic information as a pure-tone threshold acuity technique.

It appeared that the sequence of a pretest followed by training and than a post-test was valuable in testing the auditory acuity of trainable mentally retarded children. There were significant changes between the pretest and post-test thresholds with the blinking light technique, the speech reception technique, and the technique using the Pediacoumeter. With the ear-choice technique, however, there were no significant changes in thresholds between the pretest and the post-test.

Implications

The chief implication of this study was that trainable mentally retarded children can respond meaningfully to audiometric testing. The children used in this study responded meaningfully when both speech and pure tones were used as the stimuli.

The pure tone threshold acuity techniques varied in the results they gave. The blinking light technique was the simplest of the pure-tone threshold acuity techniques used in this study. It was concluded from the results of this study that this was the best pure-tone threshold acuity technique to use with trainable mentally retarded children. The indication was that the simpler the pure-tone audiometric technique, the better the response from the trainable mentally retarded children.

The modified speech reception technique used in this study was very meaningful to the trainable mentally retarded children. This was shown by the large number of responses on the pretests with this technique. The children understood what they were hearing in this test. This indicated that the more meaningful the technique was to the children, the better the response which was received from them.

It was shown that the CA, IQ, and MA of the children did not correlate significantly with the ability of the children to perform the pretests of the pure-tone threshold acuity techniques. The post-test results, where most children responded to all techniques, suggests that training and practice are all that is needed. The implication here was that factors other than the CA, IQ, and MA are responsible for a child's response to an audiometric test. Further research should be done to determine what these factors are.

The sample of twenty-six children showed an incidence of significant hearing loss somewhere between five and 10 per cent. This incidence of hearing loss was lower than the incidence of hearing loss reported by other studies which have been done on the hearing acuity of mentally retarded children. If, in the other studies which have been done, the mentally retarded children had been given an intensive series of audiometric tests rather than only one test, the reported incidence of hearing loss probably would have been greatly reduced.

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APPENDIX

APPENDIX A

MEAN CALIBRATION CORRECTIONS IN DECIBELS FOR TDH-39 EARPHONES USED WITH THE MAICO H-1B AUDIOMETER

Frequency (cps)	Right Phone Correction in db	Left Phone Correction in db
250	2.8	2.7
500	-1.0[a]	-1.4
1000	-1.7	-1.5
2000	-4.2	-5.0
4000	3.3	2.5

APPENDIX B

MEAN CALIBRATION CORRECTIONS IN DECIBELS FOR TDH-39 EARPHONES USED WITH THE OTOMETER 600 D

Frequency (cps)	Right Phone Correction in db	Left Phone Correction in db
500	-0.5	0.5
1000	0.2	1.3
2000	-0.4	-0.1
4000	0.4	1.3
6000	1.0	0.7

[a] Minus indicates an SPL in excess of the desired level.

APPENDIX C

BASELINE DATA OF SAMPLE POPULATION

Child No.	CA	MA	IQ	School Group
1	5-4	1-8	31	Public School
2	7-2	3-4	47	Public School
3	9-11	2-5	24	Public School
4	12-0	2-9	25	Public School
5	8-0	2-6	31	Public School
6	8-8	3-0	35	Public School
7[a]	6-2	2-4	29	Public School
8	9-10	2-3	23	Public School
9	9-6	2-7	28	Public School
10	8-5	2-6	30	Opportunity Center
11	12-3	3-0	24	Opportunity Center
12	This child withdrew from the study			
13	7-11	2-2	27	Opportunity Center
14	6-9	2-6	36	Opportunity Center
15	5-8	2-5	43	Opportunity Center
16	7-10	2-2	28	Opportunity Center
17	7-3	2-0	28	Opportunity Center
18	7-3	2-3	31	Opportunity Center
19	7-10	3-5	44	State School
20	10-0	3-4	33	State School
21	9-4	3-5	37	State School
22	10-6	3-3	31	State School
23	8-7	3-7	42	State School
24	10-1	3-8	36	State School
25	10-6	3-11	37	State School
26	11-5	3-7	31	State School
27	8-4	2-5	29	State School

---

[a] The psychologist could not get any scores for this child on the first psychological examination. The CA given here was the CA of the child at the time of the first examination. The MA and IQ scores were obtained on a psychological examination about 18 months after the first examination was attempted.

APPENDIX D

SUMMARY OF NEUROLOGICAL DATA

Child No.	Neurological Data	Neurological Group
1	Mongolism, uncomplicated	Mongoloid--No Neurolog. Defect
2	Mongolism; alternating esophoria, incoordination, mild	Mongoloid--Neurolog. Defect
3	Exotropia, bilateral; lateral nystagmus, incoordination	Non-Mongoloid--Neurolog. Defect
4	Hyperreflexia, incoordination, diffuse cortical damage	Non-Mongoloid--Neurolog. Defect
5	Mild cranial asymmetry; esophoria, left	Non-Mongoloid--Neurolog. Defect
6	Mongolism, uncomplicated	Mongoloid--No Neurolog. Defect
7	Right parietal depression, probable cortical atrophy	Non-Mongoloid--Neurolog. Defect
8	Mongolism, uncomplicated	Mongoloid--No Neurolog. Defect
9	Right spastic hemiparesis	Non-Mongoloid--Neurolog. Defect
10	Diffuse cortical damage; exotropia, left	Non-Mongoloid--Neurolog. Defect
11	Mongolism, uncomplicated	Mongoloid--No Neurolog. Defect
12	This child withdrew from the study	
13	Mongolism; slow EEG; pupillary inequality	Mongoloid--Neurolog. Defect
14	Mongolism, uncomplicated	Mongoloid--No Neurolog. Defect
15	Non-specific cortical damage; internal squint, slight	Non-Mongoloid--Neurolog. Defect
16	Mongolism, uncomplicated	Mongoloid--No Neurolog. Defect
17	Diffuse cortical damage; hypertelorism	Non-Mongoloid--Neurolog. Defect
18	Esotropia and hypertrophia; right facial weakness	Non-Mongoloid--Neurolog. Defect
19	Mongolism; abnormal EEG; diffuse cortical damage	Mongoloid--Neurolog. Defect
20	Mongolism; abnormal EEG; diffuse cortical damage	Mongoloid--Neurolog. Defect
21	Congenital cerebral defect probable, diffuse	Non-Mongoloid--Neurolog. Defect
22	Abnormal EEG; spiking and slow wave formation, left	Non-Mongoloid--Neurolog. Defect
23	Biparietal flattening	Non-Mongoloid--Neurolog. Defect
24	Cranial asymmetry; alternating convergent squint	Non-Mongoloid--Neurolog. Defect
25	EEG normal; physical findings non-specific	Non-Mongoloid--No Neurolog. Defect
26	Mongolism, uncomplicated	Mongoloid--No Neurolog. Defect
27	EEG abnormal; congenital cortical defects	Non-Mongoloid--Neurolog. Defect

[illegible]
Part II

The Evaluation and Development of Techniques for

Testing the Visual Acuity

of Trainable Mentally Retarded Children

Project Director
William G. Wolfe, Ph.D.

Research Associate
Jasper E. Harvey, Ph.D.

THE UNIVERSITY OF TEXAS • AUSTIN

December, 1959

#3

FOREWORD

This study is Part II of a two-part investigation authorized as Project Number 172 (6447), Cooperative Research Program, United States Department of Health, Education and Welfare, Office of Education. The title of the major project is as follows:

Comparative Investigation of Methods of Testing
Auditory and Visual Acuity of Trainable
Mentally Retarded Children

This portion of the major project was completed in August, 1959, in the Department of Educational Psychology, College of Education, The University of Texas, Austin, Texas, by Dr. Jasper E. Harvey, Research Associate, and was directed by Dr. William G. Wolfe, Professor of Educational Psychology.

ACKNOWLEDGMENTS

Many individuals made important contributions to this research. Special thanks should be extended to Dr. Benjamin Fruchter, Dr. Lennart L. Kopra, Dr. John R. Peck, and Dr. James W. Reynolds, for their guidance and professional advice during the two years this research was being conducted. Without the help of Mr. Jack Mills, Mr. James MacPherson, and Mr. Joe Grantham, Research Associates and Assistant on the major project, this study would not have been completed.

It would not have been possible to complete this study without the excellent cooperation of the members of the staff of the Austin State School, the Wooldridge Elementary School, and the Austin Opportunity Center for Retarded Children. Both the teachers and the Administrators were very generous in allowing the children to be taken from classes for visual testing.

Particular thanks should be extended to Dr. Douglas F. Barkley and to Dr. Ramon Burstyn for their technical guidance and professional advice. Dr. Barkley was the examining ophthalmologist for the project. Dr. Burstyn served as technical consultant for the modification of the optical systems used in this research.

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CHAPTER I

BACKGROUND OF THE RESEARCH PROBLEM

A. Introduction

The severely retarded child has been known for many years. Itard (69) was among the first to record a study of the severely retarded. In 1799, a boy approximately twelve years of age was found in the forest of Aveyron. The child resembled a wild animal in that he was unable to speak, selected his food by smell, attempted to escape, and in general acted more as an animal than as a human being. Boyd (60) stated that the boy was brought to the Academy of Science in Paris, where he was diagnosed by Pinel as an incurable idiot, and unable to profit from education. Itard, a philosopher and physician, who was inspired by the philosophy of sensationalism and the post-revolutionary belief that man had unlimited possibilities, explained that the apparent level of intellect of the boy was the result of his environmental background. Itard initiated an extensive training program for the boy with the intent of demonstrating, through the sensory modalities, the educability of an apparent idiot. Within this attempt at mental training through sensory stimulation, Itard initiated visual training. The training was described by Kirk and Johnson (70):

> Large visual objects were contrasted with small ones because of their ease of discrimination. Then finer visual discriminations were introduced. Itard succeeded in conditioning the boy to certain words such as 'milk' (lait), and produced an association between the printed word and the milk. The boy learned a number of words and could read them and write some of them before the experiment was terminated. (p. 73)

According to Wallin (79), Seguin, who was first a teacher and later a medical and surgical student under Itard, modified and systematically elaborated the methods used by Itard for training the retarded. Seguin also worked toward the education of the visual abilities of his students. Kirk and Johnson (70) stated:

> The education of visual abilities involved the use of colors, forms and combinations of forms, dimensions, distances, and planes. These were taught through the use of objects which the child actually handled and manipulated. In conjunction with this work, Seguin took the opportunity to again stress the importance of the hand as a helper to the eye. (pp. 77-78)

About 1879, Montessori became interested in mental defectives. After studying the work of Itard, and particularly the work of Seguin, she concluded that the problem of mental deficiency was primarily an educational rather than a medical problem. Montessori agreed with Seguin that major importance was to be given to sensory and muscular training as a part of the early education of mentally retarded children. Kirk and Johnson (70) described Montessori's method of training visual abilities.

During the nineteenth century it was believed that the normal individual, as well as the mentally defective, obtained his knowledge and his mental ability through sensory processes. Educational practices were aimed primarily at sense and muscular training. In the early part of the twentieth century, Decroly and Binet broke away from this type of education. According to Kirk and Johnson (70), these men advocated the implementation of learning through experiences.

Dallenbach (6) reported the earliest modern experiment involving the visual abilities of retarded individuals. He found that the effect of practice in visual apprehension in the retarded was characterized by a slow and gradual improvement. Dallenbach (6) also found a direct correlation between the range of visual apprehension and mental age.

Kirschen (33) has reported a study of the visual acuity of retarded children. The study was the only one reported in the literature which had as its objective the investigation of visual acuity of retarded children. Although Kirschen's techniques were largely clinical in nature, he concluded that there was a direct relationship between the physical abnormality of the child and the visual anomaly.

There remained the problem of an efficient, reliable, and valid screening test for use with the trainable mentally retarded. Was that child adequately screened for visual acuity by standardized, commercially available instruments, or were there other factors which must be considered?

B. Problem

The present comparative investigation of methods of testing the visual acuity of trainable mentally retarded children was designed to be a systematic study of a selected population. The study was concerned with: (1) the comparative investigation of the performance of the trainable child on commercially available test instruments designed to determine visual acuity and muscle deviation; (2) the kinds of perceptual behavior which were observed when pictures, figures, silhouettes, or letters were presented tachistoscopically for varying lengths of time; (3) the extent to which commercially available tests of visual acuity and of muscle deviation and the extent to which modified/constructed tests designed to determine visual efficiency interrelated, measured the same thing, or evaluated various aspects of vision and/or perceptual responses of trainable mentally retarded children; and (4) the extent to which commercially available test instruments designed to determine visual acuity and muscle deviation

C. Significance of Study

The present investigation was the first controlled study of methods of testing the visual acuity of trainable mentally retarded children. There had been much speculation--but no empirical data with which to confirm that speculation--that there were children who had been labelled as trainable mentally retarded children and who were functioning at the level of trainable children because of undetected, undiagnosed, and uncorrected visual anomalies. The intent of this investigation was (1) to determine the validity of commercially available tests of visual acuity and muscle deviation and to determine the validity of modified/constructed tests designed to determine visual efficiency when used with trainable mentally retarded children by comparing screening findings with clinical ophthalmological findings; and (2) to determine whether or not there were children within the experimental population used in this study who were functioning at the level of trainable mentally retarded children rather than at a higher level of intellectual functioning because of visual anomalies.

The information obtained from this study will be useful in helping to solve some of the significant problems relating to the usable vision of trainable mentally retarded children. The results of the study indicate the most valid and efficient methods of testing the visual acuity of the trainable mentally retarded child on the basis of comparison with independent clinical findings by an ophthalmologist. The results of this study also furnish information relating to the problems involving the kinds of behavior which were associated with responses to various visual targets when presented through standard viewing procedures and through tachistoscopic presentation for varying lengths of time. The kinds of behavior manifested by each child are included in Appendix B.

D. Definition of Terms

Words have a variety of semantic connotations. In an attempt to prevent misunderstanding, the following terms are defined.

1. Acuity/visual. English and English (64) explained visual acuity in this manner:

> . . .the ability of the human mechanism to distinguish small spatial separations or intervals between portions of the visual fields. The closer two points can be distinguished as two, the higher the acuity. (p. 11)

2. Acuity/sensory. English and English (64) referred to sensory acuity as:

> . . .the ability to respond to sense data of low intensity, duration or extent. Included is the ability to respond to "something there" when one is unable to discriminate what is there. (p. 10)

This investigation attempted to determine the level of sensory acuity of the individual subject through tachistoscopic presentation of visual stimuli. Sensory acuity precedes visual acuity, not as an "either or" proposition but as points on a continuum.

3. Anomaly. Anomaly was defined by English and English (64) as:

> . . . that which is markedly irregular, exceptional, deviating from the typical, but not necessarily diseased or pathological. (p. 32)

4. Convergence. English and English (64) defined convergence in this manner:

> Tendency toward one point; esp., position or movement of the eyes such that light from a single source falls on the two foveas; the turning of the eyes inward when viewing binocularly an object less than 20 feet away. (p. 121)

5. Diopter. Diopter was explained by English and English (64) as follows:

> . . . a unit used in measuring the power of a lens to bring parallel rays of light to a focus; it is the focal distance of the lens in meters divided into unity. The values are plus for convex lenses (which facilitate seeing near objects), minus for concave lenses (which facilitate seeing distant objects). (p. 154)

6. Educable Mentally Retarded. Ingram (68) explained the educable mentally retarded:

> About 2 per cent of the school population have definite mental limitations so extreme that their failure to succeed in school with average children is conspicuous. These children require a special program for mental, social and emotional education if they are to become self-supporting.
>
> . . . .
>
> The intelligence quotient range from 50 to 75 is the approximate range most widely accepted. (pp. 5-6)

7. *Emmetropia*. English and English (64, p. 176) explained emmetropia as "normal vision."

8. *Etiology*. Pepper (73, p. 124) explained etiology as ". . . the knowledge of the cause or origin of the disease."

9. *Exceptional Children*. Baker, Charters, Kirk, Martens, and Stullken (67) stated that exceptional children are those individuals:

> . . . *who deviate from what is supposed to be average in physical, mental, emotional, or social characteristics to such an extent that they require special educational services in order to develop to their maximum capacity*. (p. 3)

10. *Hyperopia*. Hyperopia was defined by English and English (64, p. 244) as ". . . a condition in which the light rays come to focus behind the retina instead of directly upon it."

11. *Mental Deficiency*. Doll's (9) description of mental deficiency was:

> Mental deficiency is a state of social incompetence obtaining at maturity, or likely to obtain at maturity, resulting from developmental mental arrest of constitutional (hereditary or acquired) origin; the condition is essentially incurable through treatment and unremediable through training except as treatment and training instill habits which superficially compensate for the limitations of the person so affected while under favorable circumstances and for more or less limited periods of time. (p. 217)

12. *Myopia*. English and English (64) defined myopia as:

> . . . a condition of the eye in which, with relaxed accommodation, the light rays come to a focus in front of the retina instead of directly upon it. (p. 335)

13. Ophthalmoscopy. Arey, Burrows, Greenhill, and Hewitt (58, p. 958) defined ophthalmoscopy as ". . . examination of the interior of the eye with the ophthalmoscope."

14. Over-referral. As used in this study, over-referral was the process of directing a child for professional eye care on the basis of visual screening as indicated by failure as defined by the examining ophthalmologist, but who, upon ophthalmological examination, was found not to be in need of ophthalmological care.

15. Perception. English and English (64) defined perception as:

> . . . an event in the person or organism, primarily controlled by the excitation of sensory receptors, yet also influenced by other factors of a kind that can be shown to have originated within the life history of the organism. (p. 378)

16. Pupillary Reflex. Pupillary reflex was defined by English and English (64) as:

> . . . change in the size of the pupil as the iris muscle contracts or relaxes, in response either to change in light intensity or to change in point of fixation for near or far. (p. 431)

17. Referral. As used in this study, referral was the process of directing a child for professional eye care on the basis of visual screening as indicated by failure as defined by the examining ophthalmologist.

18. Refraction/Error of. English and English (64) defined error of refraction as:

> . . .the failure to focus the optical image normally upon the retina, either because of irregularities in the shape of the eyeball or in the optical characteristics of the cornea, aqueous humor, lens, or vitreous humor. (p. 449)

19. Retinoscopy. Arey, Burrows, Greenhill, and Hewitt (58, p. 1181) defined retinoscopy as skiametry.

20. Skiametry. Skiametry was defined by Arey, Burrows, Greenhill, and Hewitt (58, p. 1257) as ". . .an objective method for investigating, diagnosing, and evaluating refractive errors of the eye."

21. Squint. Arey, Burrows, Greenhill, and Hewitt (58, p. 1292) defined squint as "Strabismus."

22. Statistical Terminology. In discussing the nonparametric techniques of hypothesis testing which were used in this study, Siegel (75) stated:

> I believe that the nonparametric techniques of hypothesis testing are uniquely suited to the data of the behavioral sciences. The two alternative names which are frequently given to these tests suggest two reasons for their suitability. The tests are often called 'distribution-free,' one of their primary merits being that they do not assume that the scores under analysis were drawn from a population distributed in a certain way, e.g., from a normally distributed population. Alternatively, many of these tests are identified as 'ranking tests,' and this title suggests their other principal merit: nonparametric techniques may be used with scores which are not exact in any numerical sense, but which in effect are simply ranks.
>
> . . . .

> A final advantage of the nonparametric tests is their usefulness with small samples, a feature which should be helpful to the researcher. . . . . whose samples must be small because of their very nature (e.g., samples of persons with a rare form of mental illness, or samples of cultures). (p. vii)

The sample size used in this study was of necessity small by its very nature, i.e., the exhaustive baseline data which were compiled for each subject. Terms which are peculiar to the nonparametric treatment used with the data are defined:

> p: Probability associated with the occurrence under the null hypothesis of a value as extreme as or more extreme than the observed value.
>
> T: In the Wilcoxon test, the smaller of the sums of like-signed ranks.
>
> ≤: Is equal to or less than. . .

23. Strabismus. Strabismus was defined by Arey, Burrows, Greenhill, and Hewitt (58, p. 1307) as a ". . . deviation of the eye which the patient cannot overcome."

24. Syndrome. English and English (64, p. 540) discussed syndrome as ". . . the pattern of symptoms that characterizes a particular disorder or disease."

25. Trainable Mentally Retarded. The Board of Directors of the National Association for Retarded Children (39) described this type of child as follows:

> Trainable mentally handicapped children are those who develop at such a slow rate that they are unable to profit from the program of instruction for the educable mentally handicapped, but they have potentialities for (1) developing the abilities to adjust acceptably to the home and neighborhood, (2) improving in their ability to care for themselves in many respects, and (3) contributing to their own economic usefulness in school, in the home, and in a residential school or in a sheltered environment. . . (p. 3)
>
> . . . .
>
> Their mental development is approximately one-quarter to one-half that of the average child.
>
> . . . .
>
> Their speech and language abilities are distinctly limited but they are able to make their wants known.
>
> . . . .
>
> They are generally not capable of learning academic skills such as reading and arithmetic beyond the rote learning of some words or simple numbers. . . . (p. 4)

In terms of intelligence quotients on intelligence tests, Kirk and Johnson (70) placed the trainable mentally retarded between 20 or 25 and 40 or 50. Reynolds, Ellis, and Kiland (89) indicated that at maturity the intelligence quotient of this group will be below 50 and that their mental ages will be below eight years.

For the purpose of this investigation, the trainable mentally retarded is defined as the child whose intelligence quotient is approximately 25 to 50, inclusive, and whose mental age at maturity will not exceed eight years. The terms "trainable mentally retarded child" and "trainable child" are used interchangeably to refer to this type of child.

26. Tropia. Arey, Burrows, Greenhill, and Hewitt (58, p. 1472) defined tropia as ". . . a manifest deviation of an eye from normal position when both eyes are opened and uncovered."

27. Under-referral. As used in this study, under-referral was the process of not directing a child for professional eye care on the basis of visual screening as indicated by failure as defined by the examining ophthalmologist, but who, upon ophthalmological examination, was found to be in need of ophthalmological care.

28. Version. Version, as defined by Arey, Burrows, Greenhill, and Hewitt (58, p. 1524), referred to ". . . change of direction."

29. Visual efficiency. As used in this study, visual efficiency is used instead of the term "visual acuity" when referring to findings of the tachistoscopically presented modified/constructed tests because of the unknown amount of psychic accommodation, i.e., increased attention due to a lessening of extraneous stimuli, which was present when the child viewed the visual target on the Gerbrands tachistoscope.

CHAPTER II

REVIEW OF THE LITERATURE

A. The Trainable Mentally Retarded Child

The education of the severely retarded child goes back at least as far as 1801 when Itard published his report of the Wild Boy of Aveyron. Prior to 1850, according to Williams and Wallin (90), the United States and several European countries began residential programs for the retarded. During the period from 1850 to 1900, residential school programs continued to develop, many having school departments. A number of private residential schools also were developed during this period. It was usual for the severely retarded to be grouped together with the moderately retarded since no clear differentiation had been made between the two groups. Williams and Wallin (81, p. 1) stated: "The lower limit for school training was at about the level represented by an I.Q. of 30."

Considerable interest was developed in individual differences in school children in the last years of the nineteenth century. Special classes for the retarded in public school systems were initiated at that time, with a continuing growth in numbers since that time. Concerning these classes, Williams and Wallin (90) stated:

> These classes were quite heterogeneous at first, due in part at least to the lack of measuring devices. From about 1908 on, however, the Binet-Simon Test and its many adaptations came into general use. By 1920 the individual mental test was quite generally used as a principal criterion for the selection of children for special classes. (pp. 1-2)

The Binet-Simon Test was originally devised for the selection of children for special classes. That test, along with other mental tests, gave finer distinctions among degrees of mental retardation, and helped to stabilize the concept of three broad ranges of mental retardation. Those ranges were the upper, middle, and lower, representing intelligence levels of approximately 50-75, 25-50, and 0-25.

In education, those gradations came to be closely related to the concept of educability. Williams and Wallin (90) stated:

> There was, for example, the old dictum that 'the idiot never learns to talk, the imbecile never learns to read, the moron never learns to think.' On the basis of this type of reasoning, a distinction gradually arose between 'educable' and 'uneducable' which received considerable acceptance. (p. 2)

As the result of this type of educational thinking, a distinction developed between the "educable" and "uneducable." The dividing line came to be expressed in terms of intelligence test scores at about the intelligence quotient level of fifty. The concept of the "uneducable" came to be applied to the two lower ranges, and educational provisions for them were, in most instances, non-existent.

From 1930, local parent groups began to be organized with the objective of evolving some type of school program for the severely retarded. In 1940, these groups consolidated into the National Association for Retarded Children. That group, along with other interested organizations, brought the needs of the retarded child into clearer focus. During that period, as a part of the process of identifying the "uneducable" child more exactly, the word "trainable" came into general use. Discussing this concept, Williams and Wallin (90) stated:

> It seems to have developed primarily in relation to the 'educability' concept. Most probably it represented an attempt to bridge the gap between the terms 'educable' and 'uneducable.' Other equivalent terms are, 'severely retarded,' 'semi-dependent,' and 'middle grade.' The term 'middle range' or 'middle grade' seems on the whole preferable, because it indicates most clearly that there is a group above and below it. (p. 3)

Kirk and Johnson (70) classified children with low intelligence according to degree, according to cause or etiology, according to clinical types, and according to educational purposes. In classifying retarded children according to degree, the following subdivisions have been used: idiot, imbecile, and moron. The child with whom this study was concerned was the imbecile. Kirk and Johnson (70) described him in this manner:

> An imbecile child will probably develop some language, be trained to care for his bodily needs, and have trainability as far as daily habits and routines are concerned. He will, however, require supervision and care in his home or in

> institutions throughout his life. In terms of I.Q. the imbecile rates between 20 or 25 and 45 or 50 on intelligence tests. The criteria upon which an individual is classified as an imbecile also include whether he is uneducable in social and occupational areas. He requires or will require care and supervision as an adult as the result of a marked intellectual defect. A classification of imbecile means that the individual must remain dependent upon others for support and supervision throughout his life. (p.4)

The term, "clinical types," according to Treadgold, as cited by Kirk and Johnson (70) referred to:

> . . .mentally deficient persons who possess. . .certain anatomical, physiognomical, or pathological features which are sufficiently pronounced to enable them to be placed in special categories. (p. 6)

Such clinical types include cretins, microcephalics, hydrocephalics, mongols, and others. Medical diagnosis of these clinical types is made on the basis of physical anomalies or syndromes found in the child. Kirk and Johnson (70) indicated that more clinical types are found among the idiots and imbeciles than among the more educable moron group. Major emphasis for classification according to clinical type was made more for medical reasons than for educational reasons; however, educational prognosis is related to clinical type.

Kirk and Johnson (70) proposed that the terms "feeble-minded" and "mentally deficient" be used synonymously for the group of children who require supervision by their families or by the state. The term "trainable" also is used synonymously in referring to these children. Discussing this term, Williams and Wallin (90, p. 3) indicated that ". . . most probably it represented an attempt to bridge the gap between the terms 'educable' and 'uneducable.' " There is controversy concerning the best placement for this child. Baker (59) indicated that there were few trainable mentally retarded children in the early classes for the retarded. Wirtz (53) pointed out that parent groups, in their efforts to provide training for the trainable child, want facilities provided within the public schools. Credence was given to this statement by the "Bill of Rights" adopted by the Board of Directors of the National Association for Retarded Children (39) in 1943. The document seemed to indicate the provisions which parents of retarded children hoped to attain for their children. The provisions were:

1. Every child, including the retarded child, is important and has the right to opportunities for the fullest realization of his potentialities, however limited, for physical, mental, emotional, and spiritual growth.

2. Every child, including every retarded child, has the right to affection and understanding from those responsible for his care and guidance during his years of dependence.

3. Every American child, including every retarded child, has the right to a program of education and training suited to his particular needs and carried forward in the environment most favorable for him, whether that be the community public school, the state residential school, or his own home.

4. Every American child, including every retarded child, has the right to help, stimulation and guidance from skilled teachers, provided by his community and state as part of a broadly conceived program of free public education.

> 5. The parent of every child, including every retarded child, has the right to determine for themselves, on the basis of competent advice, the course of care, training, and treatment, among those open to them, which they believe best for the well being of their particular child and family--and to have their decisions respected by others. (p. 516)

B. Mental Retardation and Its Relationship to Visual Acuity

An investigation by Dallenbach (6) is the earliest reported which used as an experimental population a number of children who now would be considered as trainable mentally retarded. The subjects selected were those whose mental age at the time of admission to the State Institution for Feebleminded at Columbus, Ohio, as determined by the Binet-Simon Tests, averaged 7.5 years, with a mean variation of 0.58 years. The chronological age range was from 10 to 18 years. In studying the effect of practice upon visual apprehension, Dallenbach (6) found:

> . . . the effect of practice in visual apprehension in the backward and feebleminded children is characterized by a slow and gradual improvement; conversely such an improvement in visual apprehension is indicative of backwardness. (p. 82)

Dallenbach (6) found also that:

> The range of visual apprehension varies with the complexity of material and the diversity of the associations aroused. . . . The effect of practice is relatively permanent. . . . There is a direct correlation between the range of visual apprehension and mental age. . . . Individual differences are marked, but they are closely correlated

> with mental age. . . . The extent of variability is conditioned by mental age and degree of abnormality, varying inversely with the former and directly with the latter. (p. 82)

Dvorine (15) discussed seeing as a mental process. As such, awareness or perception of one's environment is intimately associated with the mental processes. Dvorine (15) stated:

> . . . the awareness or perception of one's environment and the reactions of an individual to his environment is the end result of a complex neurological pattern of organization. Its successful operation is predicted on the accurate information which is received by the brain from the specialized senses. Defective or impaired senses lead either to erroneous conclusions or to incomplete analysis and identification or meaning, and to faulty reactions. (p. 382)

Kirschen (33) reported a study which investigated the visual acuity of retarded children. The subjects included both the educable mentally retarded and the trainable mentally retarded. Kirschen (33) stated:

> The medical records of patients at institutions for aments reveal the large number of illnesses that beset these individuals and the necessity for frequent medication and treatment. Information about the type and incidence of visual handicaps among these subjects has, however, not been available. (p. 282)

The study included about one hundred patients from the Modesto State Hospital, Modesto, California. Kirschen (33), in discussing the experimental population, stated:

> Almost three times the number of children reported on here were seen by the author. From over 300 possible reports, over 200 did not have sufficient data to warrant inclusion in this study. (p. 282)

In outlining the experimental group, Kirschen (33) stated:

> The group which was tested was almost equally divided between boys and girls and the greatest number fell in the 10 to 15 year chronological age category. One of the greatest difficulties encountered was the fact that over one-half of the subjects tested had a mental age of less than five years. They had a low level of personal social behavior. Their reactions to persons, responses to overtures and commissions and adjustments to their environment were subnormal. This explains the high number of patients upon whom it was later found impossible to record useful findings. . . . Noteworthy was the fact that most of the patients were unable to verbalize intelligibly. One can easily imagine the obstacles that this would place in the path of future tests. (pp. 285-286)

Kirschen used a battery of tests--largely clinical in nature--which included versions, near point of convergence, cover test, ophthalmoscopy, retinoscopy (skiascopy), pupillary reflexes, binocularity, and visual acuity. Visual acuity was evaluated by using a modified form of the Snellen Illiterate E test. Kirschen (33) stated:

> The patient was given a wooden letter E, 18 cm. square to manipulate. The examiner from a distance of 6 M.--exposed a series of letter E's one at a time, of diminishing size and oriented in different directions. The patient was instructed to 'turn your E card until it looks like mine.' The last correct response was recorded. The tests were first taken monocularly, then binocularly. They were sometimes repeated at 3 M. (p. 285)

Kirschen (33) indicated that the results of the version test were significant in the large number of children manifesting nystagmus, as well as the variety of types of nystagmus. The cover test revealed a significant increase in the number of children with strabismus over the

1.1 to 1.8 per cent of children expected to exhibit tropias. Retinoscopy indicated a variance from that of normal children, particularly in the greater incidence of hyperopia in the group tested than within the normal population. Kirschen indicated that pupillary reflexes revealed a relatively large number of children with an abnormality. He indicated that one of the more significant findings was in the area of visual acuity. In usual practice, according to Kirschen (33), one would expect a negative correlation between myopia and visual acuity. Kirschen (33) stated:

> This was not true in 10 of the patients tested. In these cases the eye closer to emmetropia had a lower acuity than the eye with the greater refractive error. (p. 287)

The test for binocularity provided a good check of squint results. Kirschen (33) stated that:

> . . .there was one child in whom the correction of a gross visual anomaly showed little performance improvement. . . a male, age 16, with an IQ of 50. It required almost nine diopters of plus lens power to neutralize the reflex. Since the patient had never worn glasses it might be expected that the correction of such a large amount of ametropia would cause not only visual improvement but better performance as well. (p. 287)

On the basis of the high incidence of visual anomalies, Kirschen (33, p. 287) concluded that ". . .the greater the mental deficiency, the greater the physical abnormality, and the greater the visual anomaly."

Duke-Elder (62) stated that nystagmus was associated with convergent squint. The findings of Kirschen (33) regarding the large number of children with squint and nystagmus seemed to support the possibility of a syndrome linking the two anomalies.

C. Tests of Visual Acuity

The earliest recorded measure of visual acuity was devised by Euclid in 300 B.C. According to Ewing (21), the principle used in Euclid's formula, that rectangular magnitude when seen from a distance become peripheries or curves, was the first definite measure of visual acuity. Ewing (21) stated:

> . . .the principle. . .is still the most valuable in the selection of objects for the practical determination of visual acuity. (p. 5)

The next recorded investigation into visual acuity was made by Ibn el Haitham in the eleventh century. The investigation employed a written test for research in physiologic optics. In 1623, Daca de Valdes made use of mustard seed for determining the degree of myopia in the illiterate. Robert Hooke, in 1674, made the investigation which established the angle of vision as the angle subtending an arc of one minute. This finding was deduced by observations on closely approximate stars. As explained by Ewing (21), Hooke:

> . . .demonstrated by means of a rule with proper divisions for definite distances that it was impossible to distinguish divisions of less than one minute with accuracy. (p. 6)

The first types arranged for the testing of vision were printed in 1816 under the direction of Tauber, a Leipsig physician. The use of characters was employed first by Küchler in 1835 or 1836. He cut from almanacs small black pictures of men and women, cannon, guns, birds, farm implements, and animals. These were pasted on paper in the order of their size and used as objects in the measure of visual acuity. Discussing Küchler's test, Ewing (21, p. 6) noted that because of ". . .inequality in the legibility of the pictures due to the variety of their outlines, he recognized that the choice among them as test objects was limited." Küchler also was first to suggest a standard test procedure. His proposal included a measure of vision which would be common to all practitioners, a measure by which the vision of the same patients could be tested at varying intervals of time, and a measure of vision which would be recognized by all physicians as being exact.

In 1854, Edward Jaeger published the first test-type to be employed for measuring the distant and near vision of patients. He included with this test-type a series of lines arranged in logarithmic progression. Ewing (21) observed that since this test could be employed with anyone, it may be counted as being the second standard illiterate test.

The next tests for illiterates were arranged by Streidinger in 1860. These tests were constructed at the suggestion of Longmore, and were miniature bull's-eyes which consisted of round black dots irregularly arranged in groups of from two to nine, with a space between dots approximately equal to the diameter of the dot. Their size was based upon the principle of a bull's-eye three feet in diameter to be seen at a distance of nine hundred yards. It was this test of Streidinger's, which, according to Ewing (21), was later modified by Snellen to correspond to the one and five minute scales of Donders. Snellen published his system of tests arranged on a plan of a one minute space in a square of five minutes, as had been suggested by Donders earlier in that year, 1862. Ewing (21, p. 9) indicated that ". . .for expressing the visual acuity he /Snellen/ adopted the formula of Donders $V = \frac{d}{D}$." In the edition of 1866, Snellen included a wall chart which contained a checkerboard, ring, square, three lines placed both vertically and horizontally, an L, interrupted five minute square, a T, and a St. George's cross. The L and the interrupted square were employed in different positions. Ewing (21) identified 1873 as the year of Snellen's final adoption of the E placed in the different orientations, up, down, right, and left.

In discussing the significance of Snellen's 1873 edition, Ewing (21) stated:

> While we may rightly consider the rectangular parallelogram of Euclid, the paling fence of Jaeger and the Miniature Bull's-eyes of Longmore and Streidinger as illiterate tests, to Snellen belongs the credit of having introduced individual characters arranged on a definite scale by means of which the vision of illiterates could be measured and compared by oculists in any part of the world. (p. 9)

In 1870, Boettcher published visual tests which included four plates consisting of groups of squares and rectangles. These were arranged on the basis of a two minute angle for the squares; the rectangles were the same height as the squares, but they were two and three times as long as they were high. There was always a two minute spacing between the squares or rectangles in the group. In regard to Boettcher's tests, Ewing (21, pp. 9-10) said: "His reasons for introducing these tests were that many persons could not readily comprehend the Snellen Latin type, for instance children." Boettcher's examination required that the number of figures in each group be counted and that the differences in their sizes be indicated. He reasoned that the figures were unlearnable as they could be turned in several different positions.

New target figures were added by Galezowski in 1874. These characters were the heart, club, spade, and diamond, all in solid form. These targets were used in addition to the Snellen ring and square. Ewing (21, p. 10) noted that in the 1883 edition, Galezowski added ". . .the triangle, the T, the L, and the interrupted five minute square, and the diamond with the black center." Marini, in this same period, published a set of characters for testing illiterates. According to Ewing (21, p. 10), Marini added ". . .the square, cross, L, and ring of Snellen, the horseshoe, the trident, the hook and the key." These targets were arranged on the basis of the one and five minute angles and for the distances in feet of twenty, thirty, forty, fifty, seventy, and one-hundred.

In 1878, Albini added several new test objects for the illiterate. Among the targets was a hand closed except for the pointing forefinger. Regarding these targets, Ewing (21) stated:

> Evidently they were unsatisfactory, as they were omitted from the second edition published in 1882. In the third edition, published in 1885, the E of Snellen was adopted. (p. 11)

Pfluger published a set of Optotypi in 1884 in which he arranged letters with characters for the illiterate on the same line. The characters were some of those of Snellen, the square, cross, two parallel one minute lines placed three minutes apart, and parallel lines. Pfluger also employed the E with the center line shortened two minutes, and he added an inverted pyramid which consisted of a five minute black line one minute in width, a one minute space and a black square one minute in size. Ewing (21) constructed a set of tests for illiterates in 1886. Concerning these, Ewing (21) stated:

> Because of the difficulty in inducing children and. . .illiterates to name the position of the Snellen E, or to hold its duplicate in the hand in the same direction as the character

> on the chart, the author constructed a set of test-type for illiterates in 1886 which consisted of the square, the ring, the cross, the crescent, the horseshoe, the pitcher, the star, the straight chair and the rocking chair.
>
> Experience with these characters demonstrated that the crescent was worthless as a test object, that the outlines of the pitcher were such that it was often confused with the square, and that an improvement could be made in the legibility of the star. For these reasons a new edition was published . . . in 1902 from which the crescent was omitted and corrections were made in the pitcher and the star. Also three other characters were added, a heart, a teapot and a tin cup or mug, all in outline. . . the teapot has been found to be somewhat more difficult of recognition than the others and the chair is a little more easily recognized. The legibility of all these characters compares favorably with the test letters of the same approximate size so that they may be readily interchanged. (p. 13)

The broken ring test was introduced by Landolt of Paris in 1888. Ewing (21) stated that:

> The ring was selected because of its continuous outline and round form, no one part of it being more readily recognized than any other part. Twenty-one years later this test object was adopted by the International Ophthalmic Congress as the standard international test object, by which all other test objects should be graded. (p. 13)

In 1891, Jackson introduced a new test object on a one and three minute scale. Ewing (21, p. 13) stated that his purpose was ". . . to obtain a test object which would be legible and yet smaller than the standard five minute angle of Donders employed by Snellen."

Wolffberg, in 1892, published a card of illiterate test items which were constructed on the one minute scale for the thickness of the lines but ignoring the five minute angle for the size of the objects.

He revised the test in 1910 and, in the same article, introduced the cross-point test which consisted of four squares, each three minutes in diameter, three of them black and the fourth black with a central white dot one minute in diameter constructed in the form of a cross about a central white square three minutes in diameter. In 1915, Wolffberg designed the line-point test which Ewing (21) described as:

> . . .an octagonal board on one side of which at the center was a line one minute in width and five minutes long. On the other side there was a line seven minutes long with a one minute break one minute from the end. . .By reversing the octagonal board the patient was to determine the line which contained the break. (pp. 15-16)

Allbrand published a set of illiterate tests on the Snellen scale in 1894. These tests, as discussed by Ewing (21), consisted of two one minute lines, five minutes in length, joined in an acute angle. The target was employed by being turned in different directions. Ewing (21) noted that in 1899, Lotz published tests which employed a single line vertical and two lines horizontal or vertical and the St. Andrew's cross. A year later, in 1900, Praun constructed and published a series of test objects on the plan of a clock. The test was to locate the position of the hands. Praun's test, as discussed by Ewing (21), used the one minute angle for thickness of line, a four minute angle for the length of the short hand of the clock, and a five minute angle for the length of the long hand. In 1901, Von Ammon modified the E and, according to Ewing (21), did this by,

> . . . cutting away the corners of the blocked end of the test. . . his purpose being to equalize the black of the two ends of the test. It was employed by turning in different directions as with the Snellen E. (p. 18)

Ewing (21) summarized tests introduced from 1903 through 1915. Heimann reintroduced the hand with a pointing forefinger in 1903. The hand was drawn on the one minute scale for the finger. The manner of using the target was by pointing the finger in different directions corresponding to the direction of the test finger. In 1908, Thorington published an illiterate test card which he originated. Among the new targets presented were a wheel, lamp, flag, and house. Pergens introduced a set of primary tests in 1909 which consisted of a visual unit in the form of a square. According to Ewing (21) these were used for the purpose:

> . . . of determining position, position in connection with an angle, median aperture, aperture on the side, aperture at corner, aperture at the periphery, primary separation, double or secondary separation, treble or tertiary separation, confusion separation, central linear separation, numerical point separation, numerical line separation, all on the basis of the one and five minute tangent. (pp. 19-20)

Reber introduced a test card in 1911 which contained new test objects. These were a cup, a hand (palm open), a gate, a cat sitting sideways, a horse in side view, a dog in side view, a flag, a derby hat, a wheel, a hammer, a chair, and a pair of opened scissors. In 1915, Kinney printed a set of Snellen's one and five minute lines, using them in groups of two or more by shortening one of the lines to a four minute tangent.

The test required the child to select the shortened line in the group of lines.

Ewing (21) in 1916, suggested to the American Ophthalmological Society:

> . . . that a one minute break be placed in the central line of the three line one and five minute test of Snellen, this to be arranged with other three line one and three minute groups, the test being to select from the several groups the group containing the one minute break. (p. 20)

In 1918, the Committee on the Standardization of Test Cards of the Ophthalmic Section of the American Medical Association recommended nine characters as the best so far devised for illiterate test objects. The report of the Committee on Standardizing Test Cards (31) made note that more than 180 different figures were tested. The characters suggested by the committee consisted of the ring, square, star, pitcher, horseshoe, flag, fork, and chair. Ewing (21) stated that these nine objects were selected as targets from:

> . . . all characters heretofore presented on the subject, and gave the following principles upon which the selection was based:
>
> 1. The lines of which the chief framework of the character is constructed should each subtend the angle of one minute.
>
> 2. The main body of the character should conform to the five minute visual angle.
>
> 3. Slight unobstrusive variations may be made in the lengths of the lines of the characters beyond the five minute angle in order to assure legibility, as it is practically impossible to

construct pictures of ordinary well known objects in the five minute space with lines of one minute thickness.

4. Masses of black are undesirable.

5. Lines finer than would subtend an angle of one minute are to be avoided in the body of the character (pp. 20-21).

The various steps in the development of illiterate tests were chronologically arranged by Ewing (21). Those steps covered a period of more than twenty centuries, from 300 B. C. to 1918 A. D., and according to Ewing (21) were as follows:

(1) 300 B. C.--Determination of the visual limit by Euclid.
(2) 1623 A. D.--Practical determination of vision by means of mustard seed and by use of print in the prayer book by Daca de Valdes.
(3) 1674--The one minute visual angle established by Hooke.
(4) 1835-1836--Graduation of type, selection of light, selection of paper, and the arrangement of pictures for testing by Küchler.
(5) 1854--Use of lines and space in logarithmic progression (geometric progression) for determining visual acuity by Edward Jaeger.
(6) 1860--Employment of dots for testing the vision, by Longmore and Streidinger.
(7) 1866--Employment of geometric forms of practically equal size by Snellen.
(8) 1870--The introduction of one minute squares and one and three minute rectangles by Boettcher.
(9) 1773-1915--Introduction of several so-called one minute tests in white, none of them central. Snellen 1873, Landolt 1888, Jackson 1891, Pergens 1893, Von Ammon 1901, Pergens 1909, McKinney 1915, Wolffberg 1915. Of these, that of Landolt was selected as the standard visual test object by the International Ophthalmic Congress in 1909.
(10) 1910-1916--Introduction of two central one minute tests in white, Wolffberg 1910, Ewing 1916.

(11) 1919--Standardization of illiterate test objects by the Ophthalmic Section of the American Medical Association. (pp. 21-22)

Evans (20), writing in 1919 after the Report of Committee on Standardizing Test Cards was adopted, stated that the most pronounced faults of the charts then in common use were the selection of characters. He indicated that the characters were made in silhouette, line, shading, and in combinations of these; that the names of the characters were easily confused, and that a multiplicity of characters were being used. Evans (20, p. 425) stated that the various characters were ". . . markedly inaccurate as a measure of visual acuity"; and that the charts were supposedly representing objects familiar to young children. In regard to familiarity of young children with test characters, Evans (20) stated:

> The charts. . . often present figures far beyond the child's comprehension. Surely we need the help of what little understanding the child has. Illiterates may be either mentally deficient or of normal adult mind, and the chart if constructed to reach the young child, can be followed by them, but not the reverse. With this in mind it seems fair to allow 50 per cent to favor the child's mentality and the other half to gain the visual acuity. (p. 425)

The circle, cat's head, man's head, apple, and bird's head were employed by Evans (20) who indicated that the chart gave good results with children as young as three years. After a period of nine years, Cowan (5) indicated in 1928 that confusion still existed in regard to the test cards employed.

Gates and Bond (26) reported a study of the Betts Visual Sensation and Perception Tests which was conducted in 1936 with a sample drawn from a class of dull-normal children, I.Q. 75 to 90. Gates and Bond (26, p. 32) concluded that for ". . .absolute accuracy, it would be necessary to give this test at least twice to pupils of the type on which this study is based."

The Kindergarten Visual Acuity Chart was discussed by Berens (3) in 1938. Regarding the Kindergarten Chart, Berens (3) stated:

> To improve performance, interest must be stimulated, and thus a higher degree of visual acuity may be obtained. . . Even the most scientific visual-acuity charts for children. . . probably are not so accurate as the E test, which has been so well systematized. . . (p. 667)

Berens (3) stated that the purpose of the kindergarten chart was to stimulate interest by presenting figures with which the average child over three years of age was familiar. The chart was colored, that being an attempt to create interest. All figures were drawn to conform as nearly as possible with the one minute and five minute angles. That original Kindergarten Chart included a line of E's at the bottom to check visual acuity of 20/100, 20/70, 20/50, 20/40, 20/30, 20/20, and 20/10. Berens (3) pointed out that:

> The E's also permit a comparison of visual acuity obtained by means of the E test and that obtained employing the figure test. It has, moreover, been found that a single letter for each distance is less confusing when testing children. (p. 667)

The targets used in the original test were the jack-in-box, dog, two soldiers, pussy cat, Felix cat, boy and blocks, ship, dog on background, chair, elephant, clown, and squirrel.

Hitz (31) reported a study which used three methods of screening, the Snellen E chart, the Betts Visual Sensation and Perception Tests, and a standard ophthalmic examination. The results of that study, indicated at that date, 1939, that the Betts tests picked up transitory errors or errors that were not present in the normal use of the eyes.

Sjogren (52) devised a new series of test cards for determining visual acuity in children. The cards, first presented in 1939, were described by Sjogren (52):

> . . .the figure on the cards consists of a somewhat conventionalized hand where the fingers and the intervening spaces are calculated on the Snellen principle in such wise that when regarding at the distance indicated on the back of every card they appear under an angle of vision of one minute. (p. 68)

For examining small children, the procedure should be demonstrated at close range and with a large figure. Sjogren's (52, p. 68) experience with the cards indicated ". . .that even very small children down to the age of two years can easily manage the test."

English, Shmukler, and Cowan (19) discussed the Betts Visual Sensation and Perception Tests in 1939. They pointed out that the Betts method was probably a more thorough means of examining the visual performance of a child from the psychological standpoint than were other tests used at that time; however, for screening examinations, the medical rather than the psychological standpoint was preferred. Oak and Sloane (39), who also discussed the Betts method in 1939, stated that the test, as dispensed to and used by schools, did not serve to screen out the children who should be referred to an eye specialist.

In criticising the use of the Snellen E chart as the sole screening test, Eames (17) stated in 1941 that the chart:

> . . . is not very satisfactory because the test fails to screen out many patients with visual insufficiency who should be found and given glasses or treatment. (p. 1170)

Eames (17) stated further that the Snellen E missed:

> . . . many cases of hypermetropia because the vigorous accommodation of school children usually enables the hypermetropic ones to clear their vision, at least long enough to read the test types and pass the test. It also fails to pick up cases of muscular imbalance and defects of binocular vision. (p. 1170)

Referring to a survey of five hundred school children, each of whom had had a professional eye examination and for whom either glasses or treatment had been prescribed, Eames (17) stated that:

> . . . 45 percent tested 20/20 or better, notwithstanding their ocular trouble, and would have been missed in a school testing program employing the Snellen test. (p. 1170)

In September, 1947, the Council on Physical Medicine (46) found the Massachusetts Vision Test acceptable. The report (46) stated that the test was constructed on sound optical and physiologic principles and it further indicated that successful use of the test required a person experienced in the handling of children as well as in visual testing.

The Massachusetts Vision Test was developed as the result of research carried on by the Department of Child Hygiene of the State of Massachusetts. The test, first manufactured in 1940, according to Allyn (91), was described in the instruction pamphlet (87) which accompanied it as: "A screening test for hyperopia, astigmatism, near and far phoria as well as visual acuity." The test series composed of three parts. Part One screened out cases of low visual acuity, with charts constructed to minimize the possibility of memorization. Illumination of the charts was standardized, and the Snellen illiterate E was used throughout because of variation in difficulty between different letters and different numbers. Part Two detected those who may have passed the visual acuity tests but who had an hyperopic error which was latent and could have required correction. Part Three indicated cases in which there was a possible muscle imbalance.

Crane, Foote, Scobee, and Green (82) reported a study which was designed to determine the efficiency of procedures commonly used or recommended for use to screen school children. The screening procedures studied were Teacher Judgment, Snellen E Test, Bebenshon or Guibor charts for near vision, Massachusetts Vision Test, Keystone Visual Survey Tests (formerly known as the Betts Visual Sensation and

Perception Tests), combinations of some of these procedures, and two tests developed for use in industry, the Bausch and Lomb Ortho-Rater and the American Optical Sight Screener. Each child used in the study, generally referred to as the St. Louis Study, was given an ophthalmological examination. In discussing the reason for this ophthalmological examination for each child, Crane, Foote, Scobee, and Green (82) stated:

> The best measure of the efficiency of a screening procedure is the correlation of its results with the ophthalmologists's findings; the actual proportions of correct and incorrect referrals are determined by two factors, the correlation and the standard for referral. . . . .
> . . . .
> . . . the larger the number of component tests in a procedure, the higher the proportion of total referrals. This means that the multiple-test procedure gave more correct referrals, but in the absence of greater screening efficiency they also gave a higher proportion of over-referrals. (p. 2)

In correlating the efficiency of the screening procedures with the ophthalmological findings, Crane, Foote, Scobee, and Green (82) pointed out that:

> Inasmuch as the Massachusetts and Snellen Test correlate approximately 0.45 with the criterion, these are the most efficient--or least inefficient--of the procedures tested. (p. 24)

The final recommendations made as the result of the St. Louis Study, as discussed by Crane, Foote, Scobee, and Green (82) seemed to indicate:

> . . .that the Snellen Test gives as good agreement with clinical judgments as any of the multiple-test procedures, and better than most, though its referral rate is lower.
>
> School health programs, with better developed facilities for followup, may not be content with a screening program that does not refer more than half of the students who need care, so will prefer one of the multiple test-procedures. As they are now set up, the Massachusetts Vision Test is the most efficient of these. (pp. 54-55)

Leverett (36), in a discussion of school vision screening dealing specifically with over-referral and under-referral, stated:

> The task of screening is that of predicting the need for visual care on the basis of limited information. Such predictions are not infallible. Errors of under-referral and errors of over-referral are expected. Furthermore, since steps taken to reduce the one tend to increase the other, it is important that both over-referral and under--referral be considered in a thorough evaluation of screening practices. (p. 96)

Fink (23), in 1954, presented two newly developed symbols for testing visual acuity in illiterate children. The first symbol consisted of a figure with arms arranged at different angles. The method of responding to the test was for the child to place his arms in the position similar to those of the chart. The second chart presented silhouettes of hands with fingers extended in different directions. The child responded by simulating the positions of the hands on the chart with his own hand. The hand was not a new concept for a target, being a reintroduction of a target type first used by Albini in 1878, reintroduced by Heimann in 1903, and a modification of the hand introduced by Sjogren (52) in 1939.

Rosenbloom (48) reported a study which compared the validity of findings of the Massachusetts Vision Test, Ortho-Rater, Keystone Visual Survey Tests, and Eames Eye Test, checked against the findings of two professional refractionists. Rosenbloom (48) found that with a population of fourth and seventh graders:

> The comparison indicates that agreement between screening tests and professional judgment is highest for Ortho-Rater and Massachusetts batteries; is considerably lower, although statistically significant, for the Keystone battery and insignificant for the Eames Eye Test. (p. 29)

Donabedian and Rosenfeld (11) investigated the replicability of the Massachusetts Vision Test with first grade children. Regarding the results, Donabedian and Rosenfeld (11) stated:

> Whatever may be the reasons which cause variations in results, it seems evident that a single test of visual acuity does not give results that are sufficiently reliable for effective screening among young children. (p. 160)

Comparing the results of the Massachusetts Vision Test screening with the findings of ophthalmologists, Donabedian and Rosenfeld (11) pointed out that:

> . . .a very large proportion of students who have failed the Massachusetts Vision Test on two successive occasions have been found by the ophthalmologist to have required referral. (p. 161)

The Keystone View Company developed a Preschool Test (85) in 1956 for use with the Keystone Visual Survey Tests Telebinocular. The purpose of the test, as stated in the Instruction Sheet (85),

> . . .is to determine the gross visual acuity of young children at far point. It is made for the No. 46 Telebinocular and is not valid on any other stereoscopic instrument.
> The first two tests require approximately 20/70 acuity, and tests 3 and 4 require approximately 20/40 acuity. (p. 1)

Test items employed on the Preschool Test were rooster, rabbit, cat, squirrel, skillet, and glass for the 20/70 lines; items included in the 20/40 lines were apple, horse, house, chicken, table, cow, duck, and pear.

Allen (1) reported a new illiterate test in 1957. In explaining the reason for presenting a new test, Allen (1) stated:

> It appears that the illiterate E or the Sjogren hand offers the best method of testing children who can understand the idea of the tests. However, there are many children who cannot comprehend these tests but can be tested by the use of pictures. (p. 38)

Allen advocated the use of pictures within the familiar experience of children. He indicated that the subject matter should be familiar, but that in addition, it should awaken a pleasant emotional response in the child. Since children vary in their experiences, likes and dislikes, diversification of subject matter is important. In explaining the rationale of the test which he developed, Allen (1) stated:

> . . .the visual acuity of three-year-old children is only partially developed. Experience indicates that 15 feet is a useful working distance for three-year-olds and that test objects of the 30-foot size are the smallest which can consistently be recognized by three-year-olds at 15 feet. (p. 38)

Allen's Preschool Vision Test consisted of nine items, the birthday cake, telephone, man in a jeep, house with chimney, a 20/30 Snellen E, panda, flower, Christmas tree, and a man mounted on a horse. Allen (1) pointed out that the test was not:

> . . . intended to replace but to complement existing tests like the illiterate E and the Sjogren hand. It is recognized that the latter tests are undoubtedly superior and better standardized for children who can use them. (p. 40)

Allen cautioned that because of extraocular influences, the results of acuity testing in young children should be regarded as minimum values.

D. Color Vision

There is controversy as to the nature of color vision; however, those who view it as a factor which can be developed through training are in the minority. According to Peters (42, p. 244), "The presence of color blindness does not indicate any lack of clearness of seeing or of any other functional defect." Peters (42, p. 244) further stated that ". . . color blindness should be thought of as a separate defect, not related to intelligence, personality, physical condition, scholastic potentiality, or diet." What commonly is termed color blindness is the result of a diminished sensitivity to certain portions of the spectrum. On enlarging that concept, Peters (42) stated:

> . . . the color confusions and difficulties in color matching, mixing, and naming, which are so characteristic of the color blind result from perceiving combinations of colors

> in proportions which are different from the ways they are seen by the majority of individuals. (p. 241)

Dvorine (13) cited eight million as the approximate number of color blind individuals in the United States. Color perception and identification were discussed as a ". . . purely visual experience," and Dvorine (13, p. 169) pointed out that these factors are dependent not only ". . . on refraction of light by the eyes and the projection of retinal images to the visual centers of the brain, but on social and educational development as well." Dvorine (13) cited a study made by Pronko which investigated the color vision of school children in the first, second, and third grades, which indicated:

> . . . a gradual decrease in the number of color defectives as they advanced through the grades. . . . color vision follows the usual developmental pattern associated with learning and maturation. (p. 172)

Considering the act of seeing as psychological, and therefore a personal experience, Dvorine (13, p. 168) pointed out that there ". . . is no way for any individual to know how the colors that he is viewing appear to another individual." Dvorine (13) further stated, that as a generalization:

> . . . the color-blind have trouble, not with the whole spectrum, but only with certain parts of it. The long rays which are designated as the red rays may appear much darker to them, or they may not be perceived at all. In the place of red, the color-blind may see gray. Green may resemble brown to them, or it may, at times, be confused with red and orange. Blue, on the other hand, is usually confused with purple, while purple may not be perceived at all. (p. 169)

Time of exposure of color plates to the subject and brightness differences in plates are factors to be considered in color blindness. Peters (42) stated:

> Not more than five seconds should be allowed for each plate. Delayed or hesitant responses or those perceived with great difficulty are usually indications of color blindness (p. 243)

Fischoff (24) and Bridgman and Hofstettler (4) indicated that the learning of correct responses for pseudo-isochromatic plates could be cued by brightness differences in the plates.

Sloan (53) discussed the effectiveness of the pseudo-isochromatic plates which were available in 1945. Observations were made as to the plates found most diagnostic as the result of their use in work at Johns Hopkins Hospital. On the basis of Sloan's (53) findings, Dvorine (83) took the eleven plates which were most diagnostic and revised the first edition of Dvorine Pseudo-Isochromatic Plates. Dvorine (83) used the eleven plates:

> . . . as a nucleus for the second edition, new plates were created, and added, and others were eliminated in order to maintain a high percentage of normal subjects passing and color deficients failing this test. (Acknowledgment)

Dvorine (83) incorporated a series of plates which may be used to test preschool children and illiterates. Dvorine (83) described this section:

> Section two contains one demonstration plate (a blue trail on a red background) and 7 plates featuring trails instead of digits; each of these plates consists of different color combinations, but similar to the color combinations of the

> first section. The second section may be used to test pre-school-age children and illiterates, or as a corroborative test when an individual fails to identify the plates of the first section. (Introduction)

The administration of the two tests was described by Dvorine (83):

> The test is administered by means of a set of printed plates on which are many colored dots of various sizes. In the center of the plate the dots are grouped in such a manner as to form one or more digits, or a winding trail, the color of which contrasts with that of the background. Failure to identify the digits or to follow the trail correctly is an indication of defective color vision. (Introduction)

E. Perception As Related to Visual Acuity

Allport (57) presented the broad classes of perceptual phenomena under six headings. The examples for these phenomena were visual. The first of Allport's classes concerned sensory qualities and dimensions, which constitute one general aspect of the way things appear. The experienced quality in vision, called hue or color, is one of the most obvious aspects of the way a thing appears. Quality has associated with it quantities or dimensions. Allport (57, p. 60) stated: "In vision. . .the quality is 'spread out' or extended; it seems to occupy space." Related to quality is the experience of intensity or strength. As explained by Allport (57):

> One gray disc looks brighter or darker than another; one red is stronger (more 'saturated') than another; one tone may be louder or softer than another; and so on. Qualitative experiences also endure through time. (p. 60)

Qualities and dimensions are modified by the conditions and surroundings under which they are observed. Background and illumination are such modifiers. Qualities and dimensions may interact in an infinite number of ways, but the existence of qualities can never be fully accounted for by these interactions. Allport (57, p. 60) stated: "Though our perceptions as wholes are far more complex than the simple qualities and sensory dimensions, these latter are nevertheless present." There has been difficulty with terminology and classification in regard to perception. Allport (57) discussed this difficulty at length:

> Looking at the matter from the standpoint of pure conscious awareness Titchener regarded sensations as elements of consciousness, and quality, intensity, extensity, duration, and clearness as attributes (or dimensions) of sensation. This scheme proved unsatisfactory because there was nothing for the term sensation to mean except these five attributes. Aside from these it was a pure abstraction. The practice of making such fictitious 'sensations' into elements of building blocks of consciousness represented the piecemeal, mosaic theory of experience which the gestalt psychologists so vigorously challenged. It seems better, perhaps, to regard not sensation but the experience of 'quality' as a basic fact in our awareness of our world, a fact contributed by the processes of the organism itself to the energies received from the stimulus. Quality, as we have seen, is something that is unique. It is different experimentally from the dimensions with which it is nevertheless always associated. It 'comes' in the dimensions of extensity, intensity, duration, and the like; but it can never be reduced wholly to these or any other dimensions. (p. 60)

Allport's discussion of quality seems to suggest the possibility of the existence of dimension in quality per se. Some psychologists seem to feel that qualities themselves are sequential and are distributed along an unbroken continuum of small steps. An analogy has been made between the discriminable tones of amusical scale which has been described as a series of small steps and between the hues of the general modality of color which have been described as a continuous series along the base of a color pyramid. Allport (57, p. 61) stated: "This conception is probably what led the earlier introspectionists to call quality an attribute or dimension of an abstract construct, sensation." This conception would tend to effect confusion. Allport (57) offered the explanation that

> . . . The primary hues do not really form a continuum. Each is unique and at quite a distance from all the others as indicated by the corners of the color model. . . . There are many intermediate series, blends, or fusions of qualities in different degrees of intensities or strengths. Each of these blends, . . . is usually perceived as an unanalyzed, unique 'whole.' It is often possible, however, to attend to its primary components separately. Both the totality and its constituents are there, though the percept may not give us both with equal clearness in consciousness at the time. (p. 61)

The second broad class of perceptual phenomena, the figural or configurational aspects, contrasts markedly with the first. Allport (57) stated:

> Though like those in the first they are experiences arising from things in the environment, they seem even less determined by the stimulus and more determined by processes inside the organism. They exhibit strongly the effect of one thing upon another in the perceptual manifold, an effect which frequently produces optical or other illusions. They are concerned mainly with the formal properties of the things we perceive, such as shape, outline, grouping, and the like. (p. 61)

Perception seems to proceed by interrelationships within definite wholes, one part affecting other parts. Nothing ever occurs by itself. Allport (57, p. 63) explained interrelationships in this manner: ". . .a 'whole character' is formed by the ensemble that cannot be experienced in the parts when they are perceived separately." The second class of perceptual phenomena is somewhat abstract, to experience them, much of the more obvious content of the experience of things must be ignored. These phenomena relate to the form of perceptual experience rather than to its content. In every sensory modality, the individual's world consists of figures appearing against grounds. In drawings in which either portion may serve as figure or ground, there may be a shift of percept back and forth from one figure-ground experience to the opposite. An infinite variety of organizing and unifying effects occur in visual experience. A figure which is by itself simple and clear will often be very difficult to perceive when embedded as a part of a large, closely knit whole. Parts, in joining, form uniquely perceived wholes; therefore, a part embedded in the context of a whole appears different from its appearance when it is experienced separately.

The phenomenon of perceptual constancy preserves for the individual a constancy of appearance and thereby the means of recognizing and identifying objects when they are seen at different angles or in different positions. The third class of phenomena also occurs in the perception of sizes at different angles or in different positions. Allport (57, p. 63) indicated that perceptual constancy ". . . is to be found also in the perception of sizes at different distances and of colors and brightness under differing conditions of illumination." The cues which are given by the object and its surroundings enter into perceptual constancies, for they seem to be, as pointed out by Allport (57, p. 63), ". . . 'utilized' in agreement with past experience; and for the most part they give us fairly veridical perceptions."

In discussing the fourth class of perceptual phenomena, the phenomenon of the dimensional frame-of-reference of perception, Allport (57) stated:

> The aspect we are now considering refers rather to the question of what we call 'bright' or 'dull,' 'light' or 'heavy,' 'loud' or 'faint,' and the like with respect to stimuli we experience. (p. 63)

Allport (57) further illustrated the phenomenon:

> Suppose, for example, that we are presented with a lot of circular discs of the same size, one after the other. Let the discs, however, be in the form of spots of light thrown on a screen and differing over a fairly large range in brightness. We are to judge from each disc whether we consider it to be 'bright' or 'dim' or 'medium.' Though no standard of reference is given, there will probably be determined, after a series of stimuli has been presented, a degree of brightness that looks to the observer as 'neutral,' that is, a degree above which the discs appear to be 'bright' and below which they appear to be 'dim.' The individual, in other words, forms his own subjective scale of judgment. (pp. 63-64)

The fifth class of perceptual phenomena concerns concrete object character. In this reference, the term object is used in its broadest sense. Allport (57) approached the matter from subthreshold conditions:

> Suppose we are looking at some object, with a view to identifying it, under very brief exposure or under an illumination insufficient for its recognition. The exposures in a series of trials are then gradually lengthened as the illumination is gradually increased. We see at first a kind of reddish blur having a roundish form, but identification of the object does not come. Exposure or illumination are further increased and we try again. A number of trials without success, or with 'misperceptions,' may occur. Then, all at once, we recognize it. It is an apple. There is no mistaking it, for it has many telltale features. We cannot say it is just a color experience. It is not adequately characterized by its configurational or 'wholeness' properties alone. Thought it has a certain texture, organization of parts, continuity of contour, and is seen as a figure against a ground, it is something more than any of these properties. It will obey the law of size or color constancy, and one can readily establish a frame of reference for 'apples' stating whether this object appears, as an apple, to be large or small; but obviously neither of these aspects adequately describes it. (p. 64)

The concrete object character aspect of perception is most significant, for things and events appear to us not as mere qualities, dimensions, or forms, but as things and events. Allport (57, p. 64) stated that concrete object character is ". . .a fundamental property of practically all our perceptions." Allport (57) explained further:

> Perhaps the most salient feature of this phenomenon is that it represents 'meaning.' The meaning that it represents, however, is not that of mere configuration or wholeness of the object, not how large or bright the object is, but the experience of what the object is. (p. 64)

Events may be included in the definition of object, and this aspect may be extended to include the concrete character or meaning of actions and situations.

The effect of prevailing set or state is the sixth broad category of perceptual phenomena, and it is an aspect of perception in which individual differences, as well as differences in the state or set of an individual at different times, assume an important role. Allport (57) stated that perceptual set or readiness could be induced or altered by needs, emotional states, and by the individual characteristics of the perceiver. As an illustration, the use of the Rorschach test for personality diagnosis was cited. Allport (57) cautioned that one must not overlook the fact that:

> . . .the 'set to perceive' may often be based not upon any strong motivating, emotional, or personality condition, but

> upon nothing more dramatic than the frequency and familiarity of the object in the observer's experience. (p. 65)

The discussion of the major phenomena of perception included six aspects. They were sensory quality and dimension, configuration, constancy, frame of reference, concrete-object character, and the effect of prevailing set or state. Allport (57) explained:

> In the first three of the categories. . . . we were describing aspects of perception that would be likely to hold true for all individuals at all times. In the fourth and fifth categories we have also noted features that would probably be largely the same for all individuals having a common background of experience. (p. 65)

Individual differences, as well as differences in the state of an individual at different times, play an important role in the sixth aspect of perception. In summary, Allport (57) pointed out that it was clear that the problem of perceptual theory has been broadened, and that one can no longer view it as separate from that of learning. Allport (55) further stated:

> The aggregate that we have been calling perception is now becoming an aggregate of behavior. It must be considered as a physiological process or pattern developing and strengthening through time and performance, as well as one that underlies immediate experience. Instead of saying either that perceptual phenomena are strictly 'perceptual' or that they are fundamentally the operations of 'learning' we could say that perceptual theory and learning theory are two different ways of looking at the same facts. (p. 463)

Sells and Fixott (50) were in agreement with Allport (57), for they took the position that perception and learning were interdependent.

Regarding their position, Sells and Fixott (50) stated:

> Perception and learning are interdependent; the individual learns percepts by organizing factors in the immediate stimulus field according to past experience; then learned perceptual patterns aid in organizing new stimuli and facilitate learning. (p. 233)

Postman (74), in discussing a general theory of cognition, stated:

> We can conceive the perceptual process as a cycle of hypothesis-information-trial and check of hypothesis-confirmation or non-confirmation. (p. 251)

Murphy and Hochberg (38) hypothesized that diffuseness:

> . . .is characteristic of the child's earliest percepts, and that the development of parts can actually be observed as the child takes hold of, points to, and names specific aspects, while other aspects of the environment remain 'blurred' or completely undifferentiated. (p. 333)

Dickinson (7) viewed visual perception as having three main levels, not separate and distinct, but in the nature of a progression, with one level developing into another. He designated these levels as visual pattern, generic object, and specific object. Dickinson (7) explained visual pattern as:

> . . .merely a flatness, a 'thereness' of visual pattern which carries a wealth of detail, of contour and illumination. No one part has begun to stand out from any other part; parts do not exist, the field is a totality and hangs momentarily as such. (p. 338)

Generic object, the second type of the progression in visual perception, was pointed out by Dickinson (7) as:

> . . .very slight coming to prominence of letters. . .with a corresponding change in definiteness of contour; the letters are now letters in a field. . .. with contour and not merely contour of visual pattern. (p. 338)

The third and final phase of visual perception, that of specific object, Dickinson (7) described as:

> Certain characteristics appear to be much more concrete than at the previous level. . .letters. . .seem to actually come forward as they are specifically named. (p. 339)

Henle (30), in an experimental investigation of past experience as a determinant of visual perception, concluded from the results of his investigations that:

> . . .under conditions where it is possible for a perception to take any one of several possible directions, that direction will be favored, other things being equal, which perception has previously taken. (p. 21)

Henle cited an earlier study by Djang (8) which considered the role of past experience in the visual apprehension of masked forms. In that study, Djang (8) found that subjects previously trained with simple figures saw masked-figures as separate units in their respective complexes twenty times as often as did control subjects who had no experience with the simple figures. Djang (8) further stated that the experimental group saw the masked-figures seventy times more often on the first trial then did the control group. As the results of those findings, Djang (8) concluded that past experience plays an important role in our visual organization.

Vernon (78) presented stages of internal determinants of perception which were similar to those used earlier by Dickinson (7). The stages were awareness of an object, grouping or organization of the object into a generic category, and meaning or understanding. Vernon's (78) explanation of the process of perceiving began with vague awareness--a mere knowledge that something was there in the visual field--and from this beginning, there followed the generic object:

> . . .the awareness that the visual stimulation is connected with some kind of object with an existence in the visual field. . .this object falls into some general category of objects, or bears a similarity to some known class of object. This knowledge usually results from a partial differentiation of the total visual field, whereby certain parts stand out more clearly, and assume more importance than their surroundings; certain details may be noted as significant in the interpretation of the perceptual situation. (p. 9)

Vernon (78) discussed the specific object:

> . . .at this stage the grouping or organization of the field begins. As this organization becomes more and more detailed and complete, the relevant and important parts rise out of the field, the rest of which fades into the background. These parts, and especially their more important details, take on specific characteristics. . .they are recognized as appertaining to some particular and specific object. . . (p. 9)

Finally, the visual pattern takes on the meaning of a form or object in the external world. Vernon (72, p. 10) stated that ". . .the perceptual process when complete includes some form of response tendency," and that in the perception of:

> . . .familiar, 'meaningful' forms and of real objects, an immediate awareness of meaning is frequently found, although the earlier stages in the development may be observed in a highly telescoped state. (p. 11)

In discussing Titchener's context theory, Kundrat (81) stated that:

> . . .synthesis between sensation and perception may be recognized in Titchener's context theory. According to the theory, perception is regarded as a core of sensations aroused by a stimulus and the context is composed of images or secondary sensations. Meaning arises from the nexus of sensation and context which, in turn, is dependent upon the individual's experience. Consequently, Titchener anticipates the separation in perceptual theory between autochthonous and behavioral determinants. (p. 16)

Titchener (77) translated his account of the psychology of perception into generic terms:

> . . .we have, as the earliest forms of perception, some sensory complex in a kinaesthetic setting. Then comes the invasion of consciousness by images, which modify both complex and setting, and may, in course of time, largely replace the sensory elements of the one and actually displace the other. (p. 371)

According to Osgood (72, p. 194), ". . .the term 'perception' refers to a set of variables that intervene between sensory stimulation and awareness." An experiment by Miller (37) has shown:

> 1. That S can 'discriminate' intensities too low for him to be aware of them.
> 2. That there are at least three perceptual conditions: (1) when S cannot discriminate the stimulus; (2) when he can discriminate it but is not aware of it; (3) when he can both discriminate and be aware of it. For this reason we cannot equate awareness and discrimination.
> 3. That the correctness of the perception of a subliminal stimulus varies with the strength of the stimulus (p. 578)

Kundrat (81) pointed out that:

> Registration is not necessarily at the level of awareness, indexed by verbal report, since the human organism seems to be able to discriminate at an unconscious level. (p. 3)

Pratt (44) proposed that the influence of past experience probably was negligible at the sensory or afferent end of the response arc, while such effects were at a maximum at the efferent or motor end.

Hebb (66) suggested that there were different stages of perceptual learning. Siegel (51) listed three stages of perceptual development: (1) motor-somaesthetic stage in which body cues from touch and movement are most important; (2) motor-visual stage in which vision has supplanted somaesthesis as cues for orientation; and (3) visual-motor stage in which visual cues are most important for perceiving. Learning intervenes in the progression from one of these stages to the next. Riesen (47) inferred that opportunity for early visual exploration is significant as a factor in later behavior. He indicated that normal opportunities at later developmental stages could not substitute for deprivation at early stages. Sells and Fixott (50) saw perception as a process including closure, figure and ground, and generalization:

> Perception is the process whereby an individual experiences an external situation as a patterned whole rather than as discrete stimuli. Perceptual processes include closure, the organization of ambiguous stimuli into closed figures, figure and ground, the discrimination of relevant parts of the stimulus field into figure and background, and generalization, attributing evidence to similar patterns differeing in detailed stimulus characteristics. (p. 232)

F. Tachistoscopic Projection of Visual Targets

In a study of visual perception by tachistoscopic methods, Renshaw (45) reported:

> For the attainment of the maximum skill in the visual perception of forms, wholes must be seen rather than a succession of discrete and disjointed parts. Brief exposure is one item in forcing the perceiver to see shapes coherently, unitarily. Skill in aggregating the sub-units within the total lattice comes with the active effort of making seeing a species of handling response. The motor or effector processes thus come to transform the sensory impression patterns into a more stably structured field. Visual form perception becomes freed from such limiting factors as position, size, brightness, characteristic of the untrained. The trained perceiver actually utilizes a different set of functions from the untrained. (p. 223)

In a series of experiments, Bartlett (2) exposed tachistoscopically a variety of simple designs, pictures of familiar objects, and ink blots. The subjects which he used represented varying patterns of experience. In defending the use of the tachistoscope, Bartlett pointed to the fact that the glance of everyday life does not rest on any given object, but that the attention of a subject is appreciably more keen and more critical when definitely set to observe. Within this framework, a short exposure actually more closely approximates normal viewing conditions than does an unrestricted method of presentation.

Douglas (12), in a tachistoscopic study of the order of emergence in the process of perception, referred to three phases beyond sensory excitation which were essential to completion of the total process of perceptual activity. These three phases were explained by Douglas (12) as:

> . . .(1) a constructional process wherein the sensory qualities are suitably weighted and combined, each in its appropriate degree of importance, into a more or less clearly differentiated formal structure; (2) an assimilative process whereby the present percept is related to the body of past experience--compared, accepted, or rejected--and is then referred back to some part of the external environment from which it is assumed to have originated; (3) a response tendency, indicating the observer's reaction, overt or implicit, to the full implications of the percept. (p. 1)

Fehrer (22) studied the perception of learning of form under conditions involving the repeated exposure of different kinds of figures for short times. The effects of length of exposure-time and type of figure on the speed learning, and the qualitative changes in perception involved in learning were considered. The results of Fehrer's (22) investigation seemed to indicate that:

> . . .the typical course of perception, applicable to figures of all degrees of difficulty, is as follows: first there is a state of instability in which the reproductions are inaccurate and differ after each exposure of the stimulus. They may be more complex than the completed form or simpler. Gradually perception becomes more consistent. In this second stage the stimulus appears phenomenally the same for a number of exposures. This constant error is gradually or suddenly eliminated, and the third stage, the correct perception, is attained. Figures of all degrees of difficulty follow some part or all of this characteristic course. . . .Difficult figures that are learned usually pass through all three stages. The learning of easy figures. . . usually begins at the second or stable stage and most often consists in gradual progressive complication or simplification. The easiest figures. . .confine their course to the third stage. (p. 221)

Leestma (35) reported a study of age changes in tachistoscopic span. Using exposure time of approximately one hundred milliseconds, he found relatively few mean significant sex differences. Leestma (35) stated that:

> Where they occurred they consistently favored the girls. More significant sex differences occurred with meaningful material than with meaningless material. (p. 95)

The average correlation of mental age with tachistoscopic threshold span was .35. Leestma (35) concluded that:

> Differences in tachistoscopic span between individuals are not primarily the result of differences in intelligence, but rather of acquired differences in the assimilation of meaning. (p. 95)

Cruickshank, Bice, and Wallen (61), in a study of perception and cerebral palsy, were in agreement with Leestma, in that they indicated that the tachistoscopic exposure time for slides appeared to have little or no influence on performance.

Eames (18) studied the relationship between visual acuity, refractive error, and the speed of visual perception. He reported a high positive correlation between speed of visual perception and acuity, both before and after correction of refractive errors.

G. Visual Training

There have been a number of recent investigations of the effect of visual training on various visual functions. Lancaster (34), in 1944, stated:

> There are two factors which affect all sensations as they reach consciousness and become perceptions. The first is concerned with all the other sensations coming into consciousness at the same time through the visual apparatus, and not merely through the visual apparatus but through tactile, kinesthetic, auditory and all other avenues.
>
> The second factor comprises memories of past experiences. . . . .
>
> The memories of past experiences (usually unconscious) affect profoundly the various sensations. It is obvious that exercises and practice serve to build a substratum of experience, a storehouse of memories, which facilitate perception of whatever the subject of the practice and exercises. (p. 168)

Lancaster (34) stressed the effect of training, and stated that the effects were:

> 1. The facilitation of pathways and of conditioned reflexes.
> 2. The accumulation of a fund of experiences, a store-house of memories and associations, from which are evoked responses by immediate sensations, which lead to interpretations and which altogether build up and determine perception. (p. 168)

Lancaster (34) took the position that seeing is only half ocular; the other half cerebral, stating:

> One cannot say that either half is the more important since the two are equally indispensable and in practice inseparable. (p. 168)

Renshaw (45), in 1945, stated:

> Tachistoscopic training is. . . certainly not a mere memory process, dependent as some psychologists have asserted principally on the frequency of impression. Sheer repetition alone is incapable of producing the reorganization of the act of perceiving shapes which leads to high order of skill (p. 228)

Sells and Fixott (50), in a 1957 discussion of visual training, seemed to agree with Renshaw's (45) earlier position, in that they indicated that the amount of frequency of practice was an important factor in perceptual learning, but that this was not the only consideration. According to Sells and Fixott (50, p. 230), ". . . present evidence points up the educability of perception as a fertile area for development of improved visual performance." Perceptual training, as pointed out by Sells and Fixott (49, p. 230), ". . . involves practice in making perceptual judgments under conditions conducive to learning."

Postman and Bruner (43) investigated the effect of different kinds of preliminary training on threshold for perception of a gap in the outline of a circle. Preliminary exposure of open circles reduced the threshold for perception of an opening; however, previous viewing of closed circles also reduced the threshold relative to a control group, though not as much.

Gibson (28) discussed acuity in reference to perception and indicated that the psychologist is tempted to think of acuity as a baseline which defines the structural limits of perceiving. Gibson (27) stated:

> . . . acuity measures do vary with such factors as the kind of judgment required, and the lighting and the nature of the test object. Possibly they vary also with practice in the judgment demanded. (p. 403)

The effect of training on color vision has been discussed in favorable and unfavorable terms. Gallagher, Ludvigh, Martin, and Gallagher (25) found that training with color plates did not improve performance on a desaturation test, nor did training with color plates improve performance on pseudo-isochromatic tests. In that context, Gibson (28) stated that where improvement of color vision was claimed:

> It seems likely that improvement. . . was due to the increasing information about the tests themselves, which were usually some form of pseudo-isochromatic charts. (p. 405)

Radler (88) indicated that the task of training in the perceptual-motor area is that of creating a series of successful experience which lead to more and better integration. He further indicated that work with retarded children, much research is needed to define the limits within which changes in achievement are possible.

CHAPTER III

STUDY PROCEDURE

A. Introduction

This study was concerned with the evaluation and development of methods of testing the visual acuity of trainable mentally retarded children. The test batteries were divided into two series. Series I consisted of eight commercially available instruments. Series II consisted of ten modified and/or constructed tests presented tachistoscopically with limits of exposure 0.01 second to 1.0 second, inclusively. Each of the two series was administered to each child on a pretest, training, post-test basis. Test targets for Series II are included in Appendix A.

B. Environment

The laboratory in which all vision tests were administered was carefully standardized for control of environment. All wall, ceiling, and floor areas were painted with a light green non-reflective paint. Control of illumination followed that recommended by Savell (49) to maintain a relaxed ciliary muscle of approximately four millimeters. In that regard, Savell (49) stated:

> For ordinary purposes 7 to 11 foot candles of illumination on the screen is satisfactory.
>
> . . . .
>
> It is unnecessary to darken the room completely; a certain level of general illumination being actually desirable, provided no strong light, other than from the projector falls directly onto the screen. (pp. 327-328)

Hathaway (29) was in agreement with Savell as to the desired level of light. Hathaway (29) stated that the chart:

> . . . should have approximately 10 foot candles of illumination well distributed over its surface. A higher intensity compensates for some eye difficulties and makes the finding of errors more difficult. (p. 54)

The tachistoscopic environment was held constant at all times. The Gerbrands Tachistoscope selected for this study was constructed so that the child looked into the tachistoscope, thereby eliminating extraneous stimuli. The response boards were presented to the child in a black, box-type environment which simulated the tachistoscopic environment, thereby eliminating the necessity for pupillary accommodation from tachistoscope to response board and return to tachistoscope. The eye-piece of the tachistoscope was fitted with lenses which allowed the individual with an emmetropic eye to view the target from a distance equivalent to twenty feet. In addition to that modification, the eye-piece and each target cell were fitted with polarization, as described by Savell (49). As a result of that polarization, the right visual target was viewed by only the right eye and the left visual target was viewed by only the left eye. Dissociation of the eyes thereby was achieved without the child's being aware that the target was being viewed with only one eye.

C. Population

The population for this study was composed of twenty-five trainable mentally retarded children whose chronological age range at the beginning of the study was from five years, four months to twelve years, three months. The mental age range was from one year, eight months to three years, eleven months. The intelligence quotient range was from twenty-three to forty-seven, as measured by the Revised Stanford-Binet Intelligence Scale, Form L. Other criteria used to arrive at an estimation of intellectual level included behavior and appearance; relationship to the examiner; the psychologist's evaluation of sensory responses, speech, and coordination; Vineland Social Maturity Scale; projective techniques, if indicated; drawing and painting; and the general impression of the examining clinical psychologist.

The population was composed of children from three classes jointly used by a second investigation, A Comparative Investigation of the Learning and Social Adjustment of Trainable Children in Public School Facilities, Local Segregated Facilities, and State Residential Centers. The population for the classes at Wooldridge School of the

Austin Public Schools and the Opportunity Center sponsored by the Austin Council for Retarded Children was chosen from the Austin metropolitan area. Referrals were received from several sources, primarily the Austin Public Schools and the Austin Council for Retarded Children. Other sources which had knowledge of children who possibly could have qualified for the study were asked to refer known children. The parents of children recommended by referral sources were contacted to determine whether or not they desired to have their child included in the two research programs. Children placed in the class at Austin State School were selected from the resident population of the school.

D. Baseline Information

An initial visit was made to the home of each child, including children who were not given final acceptance for inclusion in the study, to obtain basic data pertaining to the physical and social history of the child concerned, and to allow an objective observation, insofar as was possible, of the social and economic standards of the home and of the behavior of the child. A visit of that nature could not be made into the home of children selected for the State School population; however, such data as were available were obtained from the files at the State School.

Each parent came to the project office where developmental and social histories were obtained. Similar information, where available, was obtained from the State School files on each child in that population.

If the information secured from the two sources mentioned seemed to indicate that the child possibly could be a trainable mentally retarded child and if his behavior and physical capabilities permitted him to participate in group situations, the child then was referred to the examining clinical psychologist for psychological evaluation. That evaluation consisted of the Stanford-Binet Intelligence Scale, Form L; the Vineland Social Maturity Scale; observation and interpretation of free drawings; the psychologist's evaluation of sensory responses, speech ability, and coordination; and the psychologist's global evaluation of the child in the testing situation.

An exhaustive medical evaluation was made of each child if the results of the psychological evaluation indicated that the child was eligible for inclusion in the study. The medical evaluation included a complete pediatric examination; a neurological evaluation which included an electroencephalogram; laboratory tests which included blood chemistry and urinalysis; and ophthalmological and otolaryngological evaluations. The ophthalmological evaluation included external examination, pupillary reactions, tension, ophthalmoscopic examination, muscle examination, and prescription of treatment or corrective lenses where indicated.

Appendix B consists of all positive findings concerning each child included in the study. Those data included consist of baseline medical, ophthalmological, otolaryngological, psychological, and diagnostic findings. In addition to those findings, anecdotal notations of the reaction of each child to Series II, the tachistoscopic battery, were included.

E. Test Procedure

The design of the investigation included two series of tests. Each series was administered to each child on a pretest, training, post-test schedule. Series I was composed of eight commercially available tests. The procedure followed in administering each of the commercially available tests was in accordance with test instructions which were included in the manual for each of the individual tests. As discussed under "Environment," Part B of this chapter, the standard physical condition in the testing situation was maintained at all times. In the case of each test which required occlusion of one eye, one examiner sat next to the child so that he could occlude one of the child's eyes while the other examiner manipulated the test items. Both examiners worked with each child in maintaining attention to visual targets and/or other stimulus or response items. All lighting was artificial and was held constant for each test session. One forty watt incandescent bulb in a spot-light was directed toward the backwall and ceiling so as to reflect light to the working surface of the desk at which the child was seated. The light source for the American Optical Illiterate E, Sjogren, and the American Optical Kindergarten Chart was an American Optical projectoscope which produced a standard eight foot-candles of light on the target area. The eight foot-candles were within the seven to eleven foot-candle range recommended by Savell (49) to maintain a relaxed pupil size of approximately four millimeters. Targets for the American Optical Illiterate E and the American Optical Kindergarten Chart were focused on a standard silvered screen one foot square, which was placed on the wall twenty feet from the child's eye position. The Sjogren targets were held against the silvered screen and illuminated by the projectoscope light source. The Massachusetts Vision Test consisted of a standard kit which incorporated its own light source. The kit was placed in front of the screen, and the child's desk was moved to the recommended twenty feet distance for testing. The Keystone Telebinocular, used with the Keystone Preschool Test, included its own standard light source. All testing was administered between the hours of 9:00 A.M. and 11:00 A.M., and between 1:30 P.M. and 3:30 P.M. If a child were reported as not feeling well or as having been ill the day previous to the scheduled testing, testing for that child was postponed. The behavior of each child was observed closely during each testing period. If a child seemed ill or fatigued, the test was interrupted, or if necessary, postponed. The testing of a "control" group indicated that each child manifested less anxiety and less fatigue when brought to the test situation with another child. In working with two children per test period, it was possible to test one child on an instrument and then allow him to play or to sit while the second child was tested on the same instrument. At the end of the first one-hour period, each child was taken to the restroom. Testing then was resumed for the second one-hour period.

The eight commercially available tests included in Series I are described below:

1. American Optical Illiterate E. The targets were presented each child using the standard AO Projectoscope and the Snellen Illiterate E slide. Additional equipment consisted of one 20/200 size E cut from a piece of plywood and painted black, a larger E printed in black on a nine by twelve inch white posterboard, and a white plastic template which was used to occlude one eye for monocular testing. To orient the child, the examiner stood directly in front of the child's desk and presented the printed E at the child's visual level. The child, having been given the plywood E, was shown how to turn the response E so

as to match its position with that of the stimulus E held by the examiner. The orientation process was carried out for each of the four arm positions--up, down, right, and left. Trial time was limited to five minutes, with all trials given while the examiner stood directly in front of the child's desk. Each time the examiner presented the stimulus E in a new position, the child was told, "Now make yours like this one." Time was given for the child to respond, then the position of the stimulus E was changed by the examiner. Following the period of orientation, which by the experimental design of the research, did not exceed five minutes, the child was immediately presented the Illiterate E vision screening test. The Illiterate E, presented by using the standard slide in the projectoscope, was graduated in size, beginning with the 20/200 line, the largest, and progressing through the 20/70, 20/50, 20/40, 20/30, and 20/20 lines. As each target E was flashed on the screen in one of four possible positions, the child was asked to respond by making the plywood response E, which he held in his hand, match the position of the E presented on the screen, i.e., if the arms of the E presented on the screen pointed down, the correct response for the child was that he make the arms of the plywood response E point down.

2. _A New Series of Test Cards for Determining Visual Acuity in Children_ (Sjogren). This series more commonly is referred to as

the Sjogren Hand Cards. Sjogren (52), a Stockholm ophthalmologist, first described the test in 1939. The description Sjogren (52) gave was:

> . . .the figure on the cards consists of a somewhat conventionalized hand where the fingers and the intervening spaces are calculated on the Snellen principle in such wise that when regarding at the distance indicated on the back of every card, they appear under an angle of vision of one minute. (p. 67)

The equipment for the Sjogren Hand Card test consisted of the standard white cards with the conventionalized hands in graduated sizes, and a white plastic template which was used to occlude one eye for monocular testing. The cards were six inches square, covered with a non-glossy plastic material which reduced glare and prevented soiling. The child used his own hand for responding to the stimulus cards of the test. Orientation for the Sjogren Hand Cards was identical to that of the American Optical Illiterate E. The examiner stood in front of the child's desk with the largest Sjogren Hand Card, which was equivalent in size to that of a 20/120 foot E. The stimulus card was presented at near point in four positions, fingers up, fingers down, fingers right, or fingers left. The presentation was in a randomly selected order. As each stimulus card was presented, the examiner told the child, "Now make yours like this." The child responded by turning his hand to match the position of the hand on the stimulus card. Following the period of orientation, the child was tested immediately with the hand cards beginning with the 6/36 meter (20/120 feet) card, then the 6/24 m. (20/80 ft.), 6/18 m. (20/60 ft.), 6/12 m. (20/40 ft.), 6/9 m. (20/30 ft.), and the smallest target, the 6/6 m. (20/20 ft.). The testing was done monocularly with an examiner occluding first one eye and then the other.

3. American Optical Kindergarten Chart. The targets for the chart were presented each child by using the standard AO Projectoscope and Kindergarten slide. Additional equipment for the American Optical Kindergarten Chart consisted of a response board with six items: a star, heart, boat, circle, square, and cross; and a white plastic template which was used to occlude one eye for monocular testing. The plywood response board, painted white, had cut out of its top surface the outline of each of the above mentioned items which were painted black. Each of the items included in the response board was the 20/200 size, i.e., the boat, when flashed on the screen, was identical in color and size to the response boat. The stimulus items, projected on the standard screen, twenty feet distant, were presented one item at the time at the 20/200 foot size and at the 20/100 foot size. The child was asked to indicate which of the items he saw, either by pointing to one of the items on the board or by lifting one of the items from the response board. After orientation, the test items were projected on the screen and the child was asked to respond. The six items,

presented on the screen in various combinations, were the boat on the 20/200 line, the circle and the cross on the 20/100 line, the square, star, and heart on the 20/70 line, the heart, cross, and square on the 20/50 line, the star, cross, circle, and square on the 20/40 line, the circle, square, star, square, and cross on the 20/30 line, the star, cross, circle, heart, and square on the 20/20 line. The test was administered monocularly while the examiner occluded first one of the child's eyes and then the other.

4. Keystone Preschool Test. The equipment for the Keystone Preschool Test consisted of one Keystone Telebinocular, No. 46, with one Keystone Preschool Test Card. The card was yellow with two rows of black outline figures. The card was used for screening at the 20/70 and 20/40 visual acuity levels. The 20/70 targets, right eye, were squirrel, skillet, and glass; left eye, rooster, rabbit, and cat. The 20/40 targets, right eye, were table, cow, duck, and pear; left eye, apple, horse, house, and chicken. The response card was an eight and one-half inch by eleven inch manila card with all targets from both the 20/70 and 20/40 lines with the addition of a pig and a bucket which were not included as items on the test. The telebinocular was placed on the desk top of a child's size desk and adjusted so that the child was physically at ease, i.e., the child did not have to strain physically to see the test items. The targets were illuminated from

a source within the telebinocular before the child's head was placed against the forehead rest of the telebinocular. Once the child was comfortably positioned, the examiner then would point with a pointer so that the tip of the pointer was at the base of the stimulus item. Beginning with the 20/70 items, the examiner pointed to each item and said to the child, "See what I'm pointing to." The examiner then directed the child's attention to the response card and said, "Show me what I was pointing to," or "Show me what you saw." Orientation was done by the examiner by pointing to the first item of the 20/70 line, the chicken, then presenting the response board, the examiner showed the child which target was indicated. The orientation procedure was done three times on the first item, the chicken, which was used as the trial item on the test.

5. Massachusetts Vision Test. Test 2, Plus Sphere, Test 3, vertical phoria, distant, Test 4A, horizontal phoria, distant, and Test 4B, horizontal phoria, near, were administered. Test 1, the Illiterate E Test for Visual Acuity was omitted since the American Optical Illiterate E was identical and previously had been presented. Equipment for the administration of the sub-tests of the Massachusetts Vision Test was included in a compact case with collapsable legs. The front of the kit was removed to reveal the Illiterate E Chart for visual acuity and a black outline on white of a house consisting of a roof,

floor, walls, window, and door. The house was used in Tests 3 and 4A, tests for distant phoria. The back, or removable portion of the kit, contained the switch for lighting, the extra lens, and a movable standard with a butterfly drawn on it, which was used as the target for Test 4B, near phoria, horizontal, and a headpiece which contained the lens and served the child as an adjustable forehead rest. Response boards used with the tests were two nine inch by twelve inch white cardboards with a black E printed on one and one the second was printed a house identical to the one painted on the kit and on the reverse side of the card was printed a butterfly with dotted lines on either side of it. Included for use with those drawings was a twelve inch, red plastic pointer. The child was seated at the desk and given the same black plywood E which was used with the Illiterate E test. Test 2, the plus sphere test, was administered either with lenses A or lenses B, according to the chronological age of the child. According to the AO School Vision Screening Test, Manual (A) (86), the recommended procedure was for lenses A to be used for grades three and above and for lenses B to be used for kindergarten, grade one, and grade two. Because of the nature of the experimental population--trainable mentally retarded children--the procedure followed in the study was to use lenses B with children whose chronological ages were seven and below and to use lenses A with children whose chronological ages were eight and above. By way of orientation, the examiner used the black E printed on the nine inch by twelve inch posterboard and reviewed the child on the four possible positions for the arm of the E, up, down, right, and left. This procedure was done while the examiner stood immediately in front of the child's desk, then it was repeated with the examiner standing at twenty feet from the child's eye position. Following that reorientation, the headpiece of the Massachusetts Vision Test kit which housed the lens was placed on the child's desk and the headpiece was adjusted to a comfortable viewing position. The plus sphere lens was placed before the child's right eye while the child's left eye was occluded automatically by the lens adjustment. The second examiner stood at the target board, and using the standard red, non-glossy, plastic pointer, encircled each of the E's on the 20/30 line. When the child failed the 20/30 line, the examiner repeated the procedure for the 20/20 line. As one examiner positioned the pointer around an E, the other examiner, who was seated next to the child, said, "Now make yours like that one." That procedure was continued for the entire 20/30 line and repeated for the 20/20 line when indicated by the child's performance on the 20/30 items. Tests 3, 4A, and 4B, using Maddox Rod lenses, were tests for vertical and horizontal phoria, distant, and horizontal phoria, near. Those tests utilized the standard drawing of the house for the vertical and horizontal phorias, distant, and the standard drawing of a butterfly as it appeared on the horizontal phoria, near, target which was built into the detachable front piece. For Test 3, vertical phoria, distant, the right lens was a Maddox Rod lens and the left lens space was open so that the child used his natural, uncorrected eye, or whatever lens correction he wore to the testing situation. A round opening of one-half inch diameter was positioned in the center of the window and a small light source emitted light from that point. The Maddox Rod lens refracted the light rays in such manner that the child saw the light as a bright, red line running horizontally through a point on the house. The examiner, who was standing near the target, i.e., the drawing of the house, moved his finger in a vertical position--top to bottom--from the roof of the house to the floor of the house, and said to the child, "Tell me when my finger touches the line." If the child were unable to respond to that command, the examiner seated next to the child gave the child a narrow red pointer and said, "Put this on the house where you saw it," as he indicated the cardboard drawing of the house. A similar procedure was followed for Test 4A, horizontal phoria, distant. For that portion of the test, the left lens space also was vacant and the right lens space contained the Maddox Rod lens. The examiner who stood next to the target gave the child the same command, "Tell me when my finger touches the line," as he moved his finger in a horizontal plane, from left to right, on the drawing of the house in order to intersect the vertical red line. If the child were unable to follow that command, he was given the drawing of the house with the pointer and told, "Put this on the house where you saw it." Test 4B, horizontal phoria, near, used the drawing of a butterfly which projected a beam of light through a small opening in the metal plate on which the butterfly was drawn. The same lenses as those used with Test 4A, horizontal phoria, distant, were used for Test 4B. The butterfly target was sufficiently close that the child was able to touch it with his finger; therefore, the examiner said, "Put your finger on the red line and push it back." If the child were unable to follow that command, the examiner then gave him the red pointer, showed him the drawing of the butterfly on the response card and said, "Put this on the butterfly where you saw it."

The equipment for the Allied Muscle Balance Test consisted of one gun-type projector which projected a red dot 7/16 inches in diameter, an adjustable stand for the projector, an adjustable screen with a red rectangle 1 1/4 inches by 6 3/8 inches placed at the horizontal center, and a pair of glasses with one red lens and one green lens. The child aligned the toes of his shoes with a one-inch red marker which was drawn on the floor at a distance of one meter (39.37 inches) from the screen. The child was shown by the examiner how the bright red dot from the projector was to be placed in the circle which was drawn within the rectangle on the screen. The examiner placed glasses on the child with the red lens first in front of the right eye. The dot was moved from its correct position within the rectangle before asking the child to aim at the center of the red circle, and to indicate when the dot was properly placed. The child was allowed thirty seconds in which to locate the dot in its proper position. The identical procedure was followed with the red lens placed in front of the left eye.

7. Visual Achievement Forms. The Visual Achievement Forms were not a test of visual acuity but were designed by Lowder (71) to give information as to the perceptual ability of children. The equipment for Visual Achievement Forms consisted of one four inch by eight inch spiral bound response booklet which contained, on separate pages, the drawings of a circle, cross, square, triangle, divided rectangle, horizontal diamond, and vertical diamond. Each of the above forms was presented on a stimulus card, and the child was given a standard primary crayon and a standard blank form and told, "Make one like this." Each child attempted each of the seven forms. A standardized protocol, as noted by Lowder (71), was followed in scoring. Bonus points were allowed for age, either chronological age or mental age, whichever was lower.

8. Dvorine Pseudo-Isochromatic Plates, Section 2. The equipment for the Dvorine test consisted of a standardized Section 2 which included one demonstration plate and seven stimulus cards, along with a small camel's hair brush for tracing. The demonstration plate was a blue trail on a red background. The child was asked to trace the trail with the small brush. The instructions were: "Red Riding Hood is going to grandmother's house. She goes down the trail like this (child is shown how to trace the trail)." The child was aided in three attempts, when necessary, then allowed three attempts on the demonstration card with no aid. If the child passed, he was presented the seven stimulus cards which followed as soon as he had passed a trail on the demonstration card. In the event that the child failed all attempts at mastering the training card, the seven stimulus cards were presented, with the possibility that the child would be able to pass some part of the color test.

Series II consisted of modified and constructed targets presented on the Gerbrands tachistoscope. Presentation time was in hundredths of a second, three presentations of each target at each time setting. The child then was asked to point to a response board to indicate the object which he had just seen.

All response boards were presented in a lighted black box designed to incorporate the environmental atmosphere of the tachistoscope.

Visual targets were delarged so as to present the Snellen twenty-feet equivalent for the fifty-six centimeters focal length of the tachistoscope. Each of the ten tests of Series II utilized target sizes of 20/200, 20/70, 20/50, 20/30, and 20/20. Response boards were constructed on a four per test, two per eye basis which allowed alternation of response board to prevent, insofar as was possible, the child's perseveration a single response item or on a single position. Test targets viewed with the right eye were reversed by the tachistoscope; therefore, right response items were photographically reversed. The five modified tests and targets used were:

1. Sjogren Hand. Targets consisted of the hand in up, down, right, and left orientations. Target was adapted from a New Series of Test Cards for Determining Visual Acuity in Children (Sjogren).

2. Kindergarten Chart. Targets consisted of boat, circle, cross, square, and heart. Each target was an adaptation from the American Optical Kindergarten Chart.

3. Snellen E. Targets used for the Snellen E consisted of the E in up, down, right, and left orientations. Target was adapted from the American Optical Illiterate E.

4. Visual Achievement. The circle, cross, square, triangle, and divided rectangle were used for targets. Targets were adapted from Lowder (71) and reproduced according to the Snellen formula.

5. Keystone Preschool. Targets used were the rooster, rabbit, cat, glass, and house. Targets were adapted from the Keystone Preschool Test.

The constructed tests were drawn from toys which were within the experiential background of the experimental population. There were five constructed tests, with each test consisting of five targets: bus, fish, boat, duck, and ball. The variation between those constructed tests consisted of the type of figure, outline or silhouette, background and target color, and context background. The constructed tests were presented in the following target types:

M/C 1. Black line drawing on white background.

M/C 2. Black silhouette on white background.

M/C 3. White line drawing on black background.

M/C 4. White silhouette on black background.

M/C 5. Black line drawing with target in context background; specifically: bus with buildings; fish with hook; boat in water; duck swimming in water; and ball with bat.

Training for Series I was defined as training for correct response at near-point—immediately in front of the child's desk, at five feet from the child's eye position, at ten feet from the child's eye position, at fifteen feet from the child's eye position, and at twenty feet from the child's eye position, for the American Optical Illiterate E, Sjogren, and American Optical Kindergarten Chart. As defined by the experimental design, training did not exceed twenty minutes per test. In the case of the Keystone Preschool Test and the Allied Muscle Balance Test, the design of the test instrument did not permit other than training for correct response at near point. No training was possible for the sub-tests of the Massachusetts Vision Test, the Visual Achievement Forms, or the Dvorine Pseudo-Isochromatic Plates, Section 2. Improvement on the above tests for which no training was possible was considered on the basis of maturation or change over time.

Training for the American Optical Illiterate E consisted of the examiner first standing directly in front of the child's desk and presenting the large E printed in black on a nine by twelve inch posterboard at the child's visual level. The child, having been given the plywood E, was shown how to turn the response E so as to match its position with that of the stimulus E held by the examiner. The training process was carried out for each of the four arm positions--up, down, right, and left. Each time the examiner presented the stimulus E in a new position, the child was told, "Now make yours like this one." Time was given for the child to respond, then the position of the stimulus E was changed by the examiner. The identical procedure was carried out for training at five feet, ten feet, fifteen feet, and twenty feet distance from the child's eye position. In no instance did training exceed twenty minutes. If the child did not train for correct response, he was tested after having been marked as "Unable to train."

Training for the Sjogren consisted of a procedure which was identical to that used for the American Optical Illiterate E. The examiner stood in front of the child's desk with the largest Sjogren Hand Card, 6/36 meter (20/120 feet). The stimulus card was presented at near point in four positions--fingers up, fingers down, fingers left, and fingers right. The presentation was in a randomly selected order. As each stimulus card was presented, the examiner told the child, "Now make yours like this." The child responded by turning his hand to match the position of the hand on the stimulus card. Time was allowed for the child to respond, then the position of the stimulus E was changed by the examiner. The procedure for training was at the five feet, ten feet, fifteen feet, and twenty feet distance from the child's eye position. In no instance did training exceed twenty minutes. If the child were not trained for correct response, he was tested after having been marked as "Unable to train."

Training for the American Optical Kindergarten Chart consisted of the child's being taken up to the screen on which the test items were projected. The examiner pointed to the stimulus item on the screen and asked the child to "Show me the one like this." Response consisted of pointing to the item on the response board or by lifting the item from the response board. For training at five feet, ten feet, and fifteen feet, the child was seated, with the response board held by one of the examiners while the other examiner pointed to a stimulus item and asked the child to "Show me the one like this." The training procedure was identical at twenty feet with the exception that the child was seated at the child's desk which was used for visual screening.

Training for the Keystone Preschool Test consisted of near-point training on three targets--rabbit, glass, and house. The examiner pointed to the rabbit on the test card with a pointer so that the tip of the pointer was at the base of the rabbit and said, "See what I'm pointing to." The child's attention then was directed to the response card which consisted of three response items--rabbit, glass, and house and said, "Show me what I was pointing to." The identical procedure was carried out for each of the three items, with careful attention being paid to the fact that the training was done in randomly selected order, not linearly, i.e., rabbit, glass, house, which would have given the child an opportunity to go from right to left or left to right and make the correct response. In no instance did training exceed twenty minutes. If the child were not trained in the twenty minutes which were allowed for training, he was tested after having been marked as "Unable to train."

In training for the Allied Muscle Balance Test, the child was shown by the examiner how the bright red dot from the projector was to be placed in the dot within the rectangle on the screen. The child was aided in placing the dot, and told when the dot was in the correct position. All training was done without use of the red and green glasses. If the child were not trained in the twenty minutes allowed for training, he was marked as "Unable to train." Since that test did require manual manipulation, notation of such inability was made. As previously noted, all training for the Allied Muscle Balance Test was done at near-point.

Training for Series II was defined as tachistoscopic presentation of a visual target from each of the five series in the following sequence: three presentations of target for each timing of .10 second, .20 second, .30 second, .40 second, and 1.00 second. When the child did not respond correctly to the target at one of the above timings, the stimulus was presented at 1.00 second for six presentations. Training time for each child was recorded. Failure to train was defined as failure to respond correctly to six tachistoscopic presentations of the target at 1.00 second. In the event that a child failed the training sequence, the 20/200 target was presented for the full sequence, which allowed the child every opportunity to respond.

Post-tests for Series I and Series II were given immediately following the training procedure. The test sequence for post-testing was the reverse of that followed in pretesting. Test sequence for Series I, pretest, was: Sjogren, American Optical Kindergarten Chart, American Optical Illiterate E, Keystone Preschool Test, Massachusetts Vision Test--Tests 2, 3, 4A, and 4B--Allied Muscle Balance Test, Visual Achievement Forms, and Dvorine Pseudo-Isochromatic Plates, Section 2. Test sequence for Series I, post-test, was: Dvorine Pseudo-Isochromatic Plates, Section 2, Visual Achievement Forms, Allied Muscle Balance Test, Massachusetts Vision Test--Tests 2, 3, 4A, and 4B--Keystone Preschool Test, American Optical Illiterate E, American Optical Kindergarten Chart, and Sjogren. Test sequence for Series II, pretest, was: Kindergarten Chart, M/C 1, Snellen E, M/C 5, M/C 2, Sjogren Hand, M/C 3, Visual Achievement, Keystone Preschool, and M/C 4. Test sequence for Series II, post-test, was: M/C 4, Keystone Preschool, Visual Achievement, M/C 3, Sjogren, M/C 2, M/C 5, Snellen E, M/C 1, and Kindergarten Chart.

The tests were given in the following sequence: Series I, pretest; Series II, pretest; training for Series I; Series I, post-test; training for Series II; Series II, post-test. All responses for pretests and post-tests--whether correct or incorrect--were accepted with a positive verbal response from one or both examiners. The response was sincere and ranged from a simple "Good!" to "That was a good

boy!" or "That was good, Sammy!" Incorrect responses in training were corrected.

CHAPTER IV

RESULTS AND DISCUSSION

Data analyzed in this chapter were derived from tabulations of the scores of twenty-seven trainable mentally retarded children on two series of visual tests. Each series was administered to each child on a pretest, training, post-test schedule. Series I was composed of eight commercially available tests. Those tests were A New Series of Test Cards for Determining Visual Acuity in Children (Sjogren), American Optical Kindergarten Chart, American Optical Illiterate E, Keystone Preschool Test, Massachusetts Vision Test, Allied Muscle Balance Test, Visual Achievement Forms, and Dvorine Pseudo-Isochromatic Plates, Section 2. Series II was composed of ten modified and constructed targets presented on the Gerbrands tachistoscope. The five modified tests used targets from A New Series of Test Cards for Determining Visual Acuity in Children (Sjogren Hand), American Optical Kindergarten Chart (Kindergarten Chart), American Optical Illiterate E (Snellen E), Visual Achievement Forms (Visual Achievement), and Keystone Preschool Test (Keystone Preschool). The five constructed tests consisted of the identical targets drawn from the experiential background of the experimental group. The variation between those tests consisted of type of figure, outline or silhouette, background and target color, and context background. Target-types for each of the modified and constructed tests are included in Appendix B.

Treatment of Data

The product-moment correlation coefficient, described by Edwards (63), was used to measure the degree of relationship present between variables X and Y, which were any two given tests. Edwards (63, p. 145) defined the correlation coefficient ". . . as the ratio between the covariance and the geometric Mean of the variances." Formula (8.6) from Edwards (63) was used in computing r, the correlation coefficient between X and Y.

Correlation coefficients were computed for the pretests, right eye and left eye, and for the post-tests, right eye and left eye, of each of the four tests of visual acuity and for the two tests for muscle deviation included in Series I. Those tests were:

1. American Optical Illiterate E and Sjogren
2. American Optical Illiterate E and American Optical Kindergarten Chart
3. American Optical Illiterate E and Keystone Preschool Test
4. Sjogren and American Optical Kindergarten
5. Sjogren and Keystone Preschool Test

6. American Optical Kindergarten Test and Keystone Preschool Test
7. Massachusetts Vision Test, Tests 3 and 4A and Allied Muscle Balance Test.

To determine the relationship of the pretest of a given test with the post-test of that same test, correlation coefficients were obtained for the four tests and one sub-test of visual acuity and the two tests for muscle deviation which were included in Series I. One test, the Massachusetts Vision Test, consisted of four sub-tests, one test of visual acuity, and three tests for muscle imbalance. The tests were:

1. American Optical Illiterate E, Pretest and American Optical Illiterate E, Post-test
2. Sjogren, Pretest and Sjogren, Post-test
3. American Optical Kindergarten, Pretest and American Optical Kindergarten, Post-test
4. Keystone Preschool Test, Pretest and Keystone Preschool Test, Post-test
5. Massachusetts Vision Test, Test 2, Plus Sphere, Pretest and Massachusetts Vision Test, Part II, Post-test
6. Massachusetts Vision Test, Test 3, Pretest and Massachusetts Vision Test, Test 3, Post-test

7. Massachusetts Vision Test, Part 4A, Pretest and Massachusetts Vision Test, Part 4A, Post-test
8. Massachusetts Vision Test, Part 4B, Pretest and Massachusetts Vision Test, Part 4B, Post-test
9. Allied Muscle Balance Test, Pretest and Allied Muscle Balance Test, Post-test.

The relationship of the ten tachistoscopically presented tests of visual efficiency was determined by computing correlation coefficients for the pretest, right eye and left eye, and for the post-test, right eye and left eye. The Snellen E was treated as the independent variable in each correlation. Such an analysis of data was made to determine the significance of the performance on each test of visual efficiency in comparison with the baseline visual test, the Snellen E. The basis for that procedure was a statement by Guibor (93) that:

> You must remember that if you develop any test yourself, that it should be subjected to confirmation with the Snellen Test Chart, because this is the most scientific method for determining vision.

That statement by Guibor was in agreement with the final recommendations made as a result of the St. Louis Study, as reported by Crane, Foote, Scobee, and Green (82), which seemed to indicate:

> . . . that the Snellen Test gives as good agreement with clinical judgments as any of the multiple-test procedures, and better than most, though its referral rate is lower.

Those tests included were:

1. Snellen E and Sjogren Hand
2. Snellen E and Kindergarten Chart
3. Snellen E and Keystone Preschool
4. Snellen E and Visual Achievement
5. E and M/C 1
6. E and M/C 2
7. E and M/C 3
8. E and M/C 4
9. E and M/C 5

Each of the above tests was subjected to analysis by the Wilcoxon matched-pairs signed-ranks test for small samples (N= 25 or less). The Wilcoxon, as cited by Siegel (75, pp. 75-79), was chosen because the study used two related samples and it yielded time-difference scores which could be ranked in order of absolute magnitude. The direction of the difference was not predicted, therefore a two-tailed region of rejection was appropriate. The region of rejection consisted of all values of $\underline{T}$ which were so small that the probability associated with their occurrence under the null hypothesis was equal to or less than .05 level of significance for a two-tailed test.

Correlation coefficients were computed to determine the relationship of the pretest of a given Series II test to the post-test of that same test. Each of the ten tests of Series II were included. The tests were:

1. Snellen E, Pretest and Snellen E, Post-test
2. Sjogren, Pretest and Sjogren Hand, Post-test
3. Kindergarten Chart, Pretest and Kindergarten Chart, Post-test
4. Visual Achievement, Pretest and Visual Achievement, Post-test
5. Keystone Preschool, Pretest and Keystone Preschool, Post-test
6. M/C 1, Pretest and M/C 1, Post-test
7. M/C 2, Pretest and M/C 2, Post-test
8. M/C 3, Pretest and M/C 3, Post-test
9. M/C 4, Pretest and M/C 4, Post-test
10. M/C 5, Pretest and M/C 5, Post-test

Correlation coefficients were computed to determine the relationship between the four Series I and Series II tests which used the same visual targets. Series I pretest of a given target-type was correlated with Series II pretest of the same target-type. Series II post-test of a given target-type was correlated with Series II post-test of the same target-type. Correlation coefficients were obtained for the following tests:

1. American Optical Illiterate E, Pretest I and Snellen E, Pretest II
2. American Optical Illiterate E, Post-test I and Snellen E, Post-test II
3. Sjogren, Pretest I and Sjogren Hand, Pretest II
4. Sjogren, Post-test I and Sjogren Hand, Post-test II
5. American Optical Kindergarten, Pretest I and Kindergarten Chart, Pretest II
6. American Optical Kindergarten, Post-test I and Kindergarten Chart, Post-test II
7. Keystone Preschool Test, Pretest I and Keystone Preschool, Pretest II
8. Keystone Preschool Test, Post-test I and Keystone Preschool, Post-test II.

The Visual Achievement Forms, one of the tests of Series I, did not indicate visual acuity, but was designed to give information on the perceptual ability of children. In a discussion of perception, Dickinson (7) designated three main levels of visual perception. These levels were viewed in the nature of a progression, with one level developing into another. He designated these levels as visual pattern, generic object, and specific object. In a similar discussion, Vernon (72, p. 10) indicated that ". . .the perceptual process when complete includes some form of response tendency," and that in the perception of

> . . . familiar, 'meaningful' forms and of real objects, an immediate awareness of meaning is frequently found, although the earlier stages /visual pattern and generic object/ in the development may be observed in a highly telescoped state. (p. 11)

Gesell and his colleagues (27, pp. 45-61; 65, 98-101, 163-169) have shown that the copying of simple geometric forms is related to perceptual ability. They also have shown that there are developmental differences among children in ability to copy simple geometric forms. Townsend (54) found that form perception was more influential in copying ability than hand-eye coordination. He reported rapid development of copying ability up to a chronological age of seven and then a deceleration. Townsend (54) also removed the effects of mental age and found a correlation of .42 between copying ability and form perception. On the basis of these studies, it was hypothesized that the form perception in terms of copying ability of mentally retarded children would differ over time. The Wilcoxon matched-pairs signed-ranks test, for small samples (N= 25 or less), as discussed by Siegel (75, pp. 75-79), was chosen because the study employed two related samples and it yielded difference scores which could be ranked in order of absolute magnitude. Since the direction of the difference was not predicted, a two-tailed region of rejection was appropriate. The region of rejection consisted of all values of T which were so small that the probability associated with their occurrence under the null hypothesis was equal to or less than .05 level of significance for a two-tailed test.

The Dvorine Pseudo-Isochromatic Plates, Section 2, of Series I, did not indicate visual acuity but were an indication of color perception. Dvorine (12, p. 169) pointed out that color perception and identification were dependent not only on ". . . refraction of light by the eyes and the perception of retinal images to the visual centers of the brain, but one's social and educational development as well." Dvorine (13) cited a study made by Pronko which investigated the color vision of children of normal intelligence in the first, second, and third grades. Pronko found that color vision followed the usual developmental patterns associated with learning and maturation. On the basis of the above studies, it was hypothesized that there would be an increase in the color discrimination ability of trainable mentally retarded children over time. The McNemar test for the significance of changes, as discussed by Siegel (75, pp. 63-67), was chosen because the study used two related samples, was the before-and-after type and used classificatory measurement. Since the alternative hypothesis specified the direction of the predicted difference, the region of rejection consisted of all values of chi square which were so large that they had a one-tailed probability associated with their occurrence under the null hypothesis of .05 or less. Formula (5.2) from Siegel (75, p. 66) was used in computing chi square. Formula (5.2) was as follows:

$$X^2 = \frac{(|A - D| - 1)^2}{A + D}$$

Correlation coefficients on three tests of Series I, as computed by the product-moment correlation coefficient, fell below the .05 level of significance. Those tests were the post-test, right eye, of the Sjogren and American Optical Kindergarten; the pretest, right eye, and the post-tests, right eye and left eye, of the Sjogren and Keystone Preschool tests; and the pretest and post-test of the Massachusetts Vision Test, Tests 3, 4A and Allied Muscle Balance Test. To determine the significance of difference between the Sjogren and American Optical Kindergarten tests and between the Sjogren and the Keystone Preschool tests, the Wilcoxon matched-pairs signed-ranks test was chosen. The McNemar test for significance of changes was chosen to determine the significance of difference between the pretests and post-tests of the Massachusetts Vision Test, Tests 3, 4A, and the Allied Muscle Balance Test.

Where the coefficient of correlation, as computed by the product-moment correlation coefficient, fell below the .05 level of significance, it was necessary to determine the significance of change between the pretest and post-test results. Two tests of Series I, the Massachusetts Vision Test, Tests 3, 4A, and the Allied Muscle Balance Test, were not correlated at the .05 level of significance. The McNemar test for significance of changes, as discussed by Siegel (75, pp. 63-67), was chosen because the two studies used two related samples, were the before-and-after types and each used classificatory measurement. In discussing the McNemar test for the significance of changes, Siegel (75) indicated that where the expected frequency, 1/2 (A + D), were less than 5, binomial test should be used rather than the McNemar test. In each of the two tests the observed frequencies were cast in a four-fold table, the expected frequencies in cells A and D were determined by the formula $E = 1/2\ (A + D)$, and it was found that E was less than five on each of the two tests; therefore, the binomial test, as discussed by Siegel (75, pp. 38-40) for small samples, was used rather than the McNemar test.

Correlation coefficients which were computed to determine the relationship between the four Series I and Series II tests which used the same visual targets fell below the .05 level of significance on post-test I, right eye and left eye, and post-test II, right eye and left eye of the Snellen E test; and fell below the .05 level of significance on all sub-tests of the Sjogren, American Optical Kindergarten, and Keystone Preschool tests. To determine the significance of difference between the pretests I and the pretests II, and between the post-tests I and post-tests II, the Wilcoxon matched-pairs signed-ranks test for small samples (N= 25 or less), as discussed by Siegel (75, pp. 75-79), was chosen because the study employed two related samples and it yielded difference scores which could be ranked in order of absolute magnitude. Since the direction of difference was not predicted, a two-tailed region of rejection was appropriate. The region of rejection consisted of all values of T which were so small that the probability associated with their occurrence under the null hypothesis was equal to or less than .05 level of significance for a two-tailed test.

Leverett (36), in a discussion of vision screening dealing with over-referral and under-referral, stated:

> The task of screening is that of predicting the need for visual care on the basis of limited information. Such predictions are not infallible. Errors of under-referral and errors of over-referral are expected. Furthermore, since steps taken to reduce the one tend to increase the other, it is important that both over-referral and under-referral be considered in a thorough evaluation of screening practices. (p. 96)

Crane, Foote, Scobee, and Green (82) indicated that the best measure of a screening procedure was the comparison of its results with ophthalmological findings. It was further stated that the

Snellen Test gave as good agreement with clinical judgments as any of the multiple test procedures.

Performance of each child on each of the four tests of visual acuity--Sjogren, American Optical Illiterate E, Massachusetts Vision Test, Test 2, and American Optical Kindergarten--was compared with clinical ophthalmological findings. The observed frequencies were cast in a fourfold table of the form illustrated below.

		Clinical Ophthalmological Findings	
		Incorrect Referral	Correct Referral
Screening Findings of Test	Referred		
	Not Referred		

The percentage of children correctly referred, and the percentage of children over-referred and under-referred were computed. Such computations were made on the basis of failure of the 20/30 visual acuity line as designated by Barkley (92). The same procedure was followed in comparing referrals on the basis of positive clinical findings of muscular involvement with referrals on the basis of failure as defined by Manual (A) (86) on the Massachusetts Vision Test, Tests 3, 4A, 4B, and failure on the Allied Muscle Balance Test as defined by _Instructions for Use of the Allied Muscle Balance Survey Tester_ (84).

A further comparison was made which considered the referral of each child by the pretest and/or post-test when compared with clinical ophthalmological findings of correctly referred, needed visual care; correctly not referred; over-referred, no finding of need for visual care; and under-referral, not referred by screening test but need for visual care indicated by clinical findings. The four tests of visual acuity and the two tests for muscle diviation of Series I were included in that comparison.

Performance by each child on each of the nine tachistoscopically presented tests of visual efficiency--Snellen E, Sjogren Hand, Kindergarten Chart, Visual Achievement, Keystone Preschool, M/C 1, M/C 2, M/C 3, M/C 4, and M/C 5--which were included in Series II was compared with clinical ophthalmological findings. The procedure for comparison was identical to that used with tests of Series I.

Analysis of Data

In the analysis of data, a decision "not to reject" the null hypothesis was made with the realization that it was made with some risk, i.e., all that was implied was that there was not enough evidence to reject the null hypothesis. A decision to "reject" the null hypothesis implied only a rejection of the null hypothesis.

Product-moment correlation coefficients were computed for the pretests, right eye and left eye, and for the post-tests, right eye and left eye for each of the four tests of visual acuity and for the two tests for muscle deviation included in Series I. Twenty-three children were included in those analyses. The number had been reduced from twenty-seven as a result of two factors, hospitalization and withdrawal from the project as the result of the family moving from the area. Correlation coefficients on each of the tests were at or above the .05 level of significance on all correlations where the American Optical Illiterate E was treated as the common variable. The data included in Table 1 consist of the correlation and level of significance of each correlation when the American Optical Illiterate E was correlated with the Sjogren, American Optical Kindergarten Test, and the Keystone Preschool Test. The American Optical Illiterate E and the Sjogren were correlated at the .01 level of significance for both the right and left eyes, pretests and post-tests. The American Optical Illiterate E and the American Optical Kindergarten Chart were correlated at the .01 level of significance for both the right and left eyes, pretests and post-tests. The American Optical Illiterate E and the Keystone Preschool Test were correlated at the .01 level of significance for both the right and left eyes on the pretest, and for the left eye on the post-test. The correlation for the right eye, post-test was

TABLE 1

CORRELATION AND LEVEL OF SIGNIFICANCE OF CORRELATION[a] BETWEEN THE AMERICAN OPTICAL ILLITERATE E AND THE SJOGREN, AMERICAN OPTICAL KINDERGARTEN, AND KEYSTONE PRESCHOOL TESTS

Test Series	Illiterate E-- Sjogren	Illiterate E--- American Optical Kindergarten	Illiterate E-- and Keystone Preschool
Pretest, Right Eye:			
Correlation	.74	.54	.58
Significance	.01	.01	.01
Pretest, Left Eye:			
Correlation	.81	.62	.76
Significance	.01	.01	.01
Post-test, Right Eye:			
Correlation	.64	.67	.45
Significance	.01	.01	.05
Post-test, Left Eye:			
Correlation	.71	.81	.58
Significance	.01	.01	.01

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[a] With 21 df, r of .526 required for .01 level of significance, and r of .413 required for .05 level of significance.

at the .05 level of significance. These data indicate that the test performances of the experimental group of trainable mentally retarded children on the three commercially available tests which were correlated with the American Optical Illiterate E were correlated at or above the .05 level of significance with the group's performance on the American Optical Illiterate E.

Table 2 consists of the correlations and levels of significance of each correlation when the Sjogren, American Optical Kindergarten, and the Keystone Preschool Test were correlated, each with the other. The Sjogren and the American Optical Kindergarten Chart were correlated at the .01 level of significance for the left eye on both the pretest and post-test. The correlation for the right eye, pretest, was at the .05 level of significance. The correlation between the tests for the right eye, post-test, was not significant. The Wilcoxon matched-pairs signed-ranks test was computed for the right eye, post-test, to determine the significance of difference between Sjogren and American Optical Kindergarten Test. Since the direction of difference was not predicted, the two-tailed region of rejection was appropriate. The region of rejection consisted of all values of $\underline{T}$ which were so small that the probability associated with their occurrence under the null hypothesis, that there was no significant difference between the two tests, was equal to or less than .05 level of

TABLE 2

CORRELATION AND LEVEL OF SIGNIFICANCE OF CORRELATION[a] BETWEEN SJOGREN, AMERICAN OPTICAL KINDERGARTEN TEST, AND KEYSTONE PRESCHOOL TEST WHEN EACH WAS CORRELATED WITH THE OTHER

Test Series	Sjogren--American Optical Kindergarten Test	Sjogren--Keystone Preschool Test	American Optical Kindergarten--Keystone Preschool Test
Pretest, Right Eye:			
Correlation	.46	.35	.87
Significance	.05	>.05	.01
Pretest, Left Eye:			
Correlation	.58	.60	.84
Significance	.01	.01	.01
Post-test, Right Eye:			
Correlation	.35	.25	.41
Significance	>.05[b]	>.05[b]	.05
Post-test, Left Eye:			
Correlation	.60	.30	.63
Significance	.01	>.05	.01

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[a] With 21 df, r of .526 required for .01 level of significance, and r of .413 required for .01 level of significance.

[b] Wilcoxon matched-pairs signed-ranks test computed to determine significance of difference between tests.

significance for a two-tailed test. The resultant T of 58 was not significant at the .05 level; therefore, the null hypothesis, that there was no significant difference between the Sjogren and American Optical Kindergarten post-test for the right eye, was not rejected. The Sjogren and the Keystone Preschool Test were correlated at the .01 level of significance for the pretest, right eye. There was no correlation between the two tests at the .05 level of significance for the pretest, left eye, and for both the right and left eyes, post-test. The Wilcoxon matched-pairs signed-ranks test was computed for the three non-significantly correlated sub-tests to determine the significance of difference between the pretests, right eye, and the post-tests, right eye and left eye. The region of rejection consisted of all values of T which were so small that the probability associated with their occurrence under the null hypothesis--that there was no significant difference between the two tests--was equal to or less than .05 level of significance for a two-tailed test. The resultant T's of zero for each of the three were significant at the .05 level; therefore, the null hypothesis--that the two tests, the Sjogren and the Keystone Test were not significantly different--was rejected for the pretest, right eye, and for the post-tests, right and left eyes. The American Optical Kindergarten Test and the Keystone Preschool Test were correlated at the .01 level of significance for both the right and left eyes, pretest, for the left eye, post-test. The left eye, post-test correlation, was at the .05 level of significance. These data indicated no significant difference between the group's performance on the Sjogren and American Optical Kindergarten or on the group's performance on the Sjogren and Keystone Preschool Test. A comparison of test performances on the Sjogren and Keystone Preschool indicated a significant difference between performance on the two tests for the pretest, right eye and for the post-test, right and left eyes. It was also found that test performances on the Sjogren and Keystone Preschool Test, pretests, right eyes, were correlated at the .01 level of significance.

As noted in the above discussion of the data included in Table 2, it was found that the correlation between the Sjogren and American Optical Kindergarten Chart was not significant for the right eye, post-test. When the data were subjected to the Wilcoxon matched-pairs signed-ranks test, the resultant T of 58 was not significant at the .05 level; therefore, the null hypothesis, that there was no significant difference between the Sjogren and American Optical Kindergarten post-test for the right eye, was not rejected. Data included in Table 3 consist of the above results along with the results indicated by the T's obtained when the non-significantly correlated right eye, pretest, and right eye and left eye, post-test, were subjected to the Wilcoxon matched-pairs signed-ranks test. In each of the three

TABLE 3

SIGNIFICANCES OF DIFFERENCE BETWEEN NON-SIGNIFICANTLY CORRELATED SUB-TESTS OF SJOGREN AND AMERICAN OPTICAL KINDERGARTEN TESTS AND BETWEEN AMERICAN OPTICAL KINDERGARTEN AND KEYSTONE PRESCHOOL TESTS

Non-Significantly Correlated Sub-test	T	Level of Significance
Sjogren--American Optical Kindergarten, Pretest, Right Eye	58	$> .05$ ($N = 20$) ($.10 \leq 60$)
Sjogren--Keystone Pre-school, Pretest, Right Eye	0	$.01$ ($.01 \leq 32$)
Sjogren--Keystone Pre-school, Post-test, Right Eye	0	$.01$ ($.01 \leq 32$)
Sjogren--Keystone Pre-school, Post-test, Left Eye	0	$.01$ ($.01 \leq 32$)

computations, the resultant T's were zero; therefore, the null hypothesis--that the two tests, the Sjogren and the Keystone Preschool Test were not significantly different--was rejected for the pretest, right eye, and for the post-tests, right and left eyes.

Due to the design of the Allied Muscle Balance Test and the Massachusetts Vision Test, Tests 3 and 4A, one eye viewed a background object while the other eye viewed a bright red line or dot depending upon the test concerned. As a result of that factor, it was not possible to treat the right eye and the left eye separately for the pretest and post-test. The product-moment correlations between the two tests on the pretests and between the two tests on the post-tests were identical, $r = .1288$, and were not significant at the .05 level. The significance of changes between the two tests, Allied Muscle Balance Test and Massachusetts Vision Test, Tests 3 and 4A, was determined by using the McNemar test for significance of changes. The alternative hypothesis was that the group's performance on the Massachusetts Vision Test, Tests 3 and 4A, and the group's performance on the Allied Muscle Balance Test were significantly different. The null hypothesis was that the group's performance on the Massachusetts Vision Test, Tests 3 and 4A, and the group's performance on the Allied Muscle Balance Test were equal. The resultant chi square for the pretests and post-tests was .1000, and since the alternative hypothesis did not specify the direction of the predicted difference, the region of rejection consisted of all values of chi square which were so large that they had a two-tailed probability associated with their occurrence under the null hypothesis of .05 or less. Inasmuch as the probability under the null hypothesis associated with the occurrence observed was $p = .80$ and was greater than the .05 level of significance, the observed value of chi square was in the region of acceptance; therefore, the null hypothesis was not rejected. The conclusion was that the group's performance on the Massachusetts Vision Test, Tests 3 and 4A, and the group's performance on the Allied Muscle Balance Test did not differ significantly.

The product-moment correlation coefficient was used to measure the degree of relationship between the pretest of a given test and the post-test of that same test. Such analysis of data was necessary to determine the change obtained as the result of training. It was hypothesized that if the pretest and post-test of a given test did not correlate significantly, there would be change as the result of training. Information contained in Table 4 consists of the pretest-post-test correlation and level of significance of correlation for the American Optical Illiterate E, Sjogren, American Optical Kindergarten, Keystone Preschool Test, and the Plus Sphere Test of the Massachusetts Vision Test. The pretest of the American Optical Illiterate E

TABLE 4

CORRELATION AND LEVEL OF SIGNIFICANCE OF CORRELATION[a] BETWEEN THE PRETESTS AND POST-TEST PERFORMANCE OF THE AMERICAN OPTICAL ILLITERATE E, SJOGREN, AMERICAN OPTICAL KINDERGARTEN, AND KEYSTONE PRESCHOOL TEST

Test Series	Illiterate E	Sjogren	American Optical Kindergarten	Keystone Preschool
Pretest and Post-test: Right Eye				
Correlation	.69	.53	.79	.66
Significance	.01	.01	.01	.01
Pretest and Post-test: Left Eye				
Correlation	.79	.76	.84	.66
Significance	.01	.01	.01	.01

[a] With 21 df, r of .526 required for .01 level of significance.

was correlated with the post-test of the American Optical Illiterate E at the .01 level of significance for both the right eye and the left eye. The pretest of the Sjogren was correlated with the post-test of the Sjogren at the .01 level of significance for both the right eye and the left eye. The same correlation, .01 level of significance for both the right eye and left eye, was obtained between the pretest and post-test of the American Optical Kindergarten Test. The pretest of the Keystone Preschool Test was correlated with the post-test of the

Keystone Preschool Test at the .01 level of significance for both the right and left eyes. The pretest and post-tests of the Plus Sphere, Test 2, Massachusetts Vision Test were correlated at the .01 level of significance. The data indicated that there was no significant change between pretest performance and post-test performance on the four tests of visual acuity included in Series I; therefore, it was concluded that training made no significant difference in the post-test performance of trainable mentally retarded children.

It was necessary to determine the significance of change between the pretest performance and post-test performance of the two tests for muscle deviation included in Series I. Table 5 consists of information concerning the significance of change between pretest and post-test performances on Massachusetts Vision Tests 3, 4A, 4B, and on the Allied Muscle Balance Test. The sub-test performances on the Massachusetts Vision Test, Test 3, distant phoria, vertical, Test 4A, distant phoria, horizontal, and Test 4B, near phoria, horizontal, were not correlated at or above the .05 level of significance. The pretest and post-test performances on the Allied Muscle Balance Test also were not correlated at the .05 level of significance. For each of the sub-tests, the observed frequencies were cast in a fourfold table, the expected frequencies in cells A and D were determined by the formula $E = 1/2\ (A+D)$, and it was found that E was less than

TABLE 5

SIGNIFICANCE OF CHANGE BETWEEN THE PRETEST AND POST-TEST PERFORMANCES[a] OF THE MASSACHUSETTS VISION TEST, TESTS 3, 4A, 4B, AND ON THE ALLIED MUSCLE BALANCE TEST

Test	Number	Smaller Frequency	Proportion
Massachusetts Vision Test:			
Test 3	9	1	$x \leq 1 = .020$
Test 4A	8	1	$x \leq 1 = .035$
Test 4B	5	0	$x \leq 0 = .031$
Allied Muscle Balance Test:			
Right Eye	7	1	$x \leq 1 = .062$
Left Eye	8	2	$x \leq 2 = .145$

[a] Binomial test. Siegel (75, pp. 38-40).

five on each of the two tests; therefore, the binomial test was used rather than the McNemar test. The null hypothesis was, for all three sub-tests of the Massachusetts Vision Test, that $p_1 = p_2 = 1/2$, that there was no difference between the probability that performance on the pretest (p_1) would be significantly different from performance on the post-test (p_2). For Test 3, Distant Phoria, Vertical, it was concluded that there was a difference in performance due to training and/or maturation. In the case of Test 4A, Distant Phoria, Horizontal, it was concluded that there was a difference due to training and/or maturation. For Test 4B, Near Phoria, Horizontal, it was concluded that there was a difference in performance due to training and/or maturation. In the case of the Allied Muscle Balance Test, for both right eye and left eye, it was concluded that there was no significant difference, for either eye, due to training and/or maturation.

The Wilcoxon matched-pairs signed-ranks test was used with data from the pretest and post-test of the Visual Achievement Forms to test the hypothesis that the form perception, of trainable mentally retarded children in terms of copying ability, would differ over time; i.e., the sum of the positive ranks would not be equal to the sum of the negative ranks on the Wilcoxon matched-pairs signed-ranks test. Since the direction of the difference was not predicted, a two-tailed region of rejection was appropriate. The region of rejection consisted of all values of $\underline{T}$ which were so small that the probability associated with their occurrence under the null hypothesis was equal to or less than .05 level of significance for a two-tailed test. Table 5 consists of the findings of the difference over time for the total group and for the three school groups, public school, Opportunity Center, and State School.

In the case of the total group, the resultant $\underline{T}$ of 44 was significant at the .05 level; therefore, the null hypothesis, that the form

TABLE 6

SIGNIFICANCE OF DIFFERENCE[a] IN FORM PERCEPTION, IN TERMS OF COPYING ABILITY, AS MEASURED BY VISUAL ACHIEVEMENT FORMS

	T	Significance
Total Group	44	.05 (.05 ≤ 46)
Public School Sub-group	0	.05 (.05 ≤ 0)
Opportunity Center Sub-group	4	> .05 (N= 6) (.05 ≤ 0)
State School Sub-group	13	> .05 (N= 7) (.05 ≤ 2)

[a] Wilcoxon matched-pairs signed-ranks test, Siegel (75, pp. 75-79).

perception of trainable mentally retarded children, in terms of copying ability, would not differ over time, was rejected. The direction of change was that of improvement. For the public school group, the resultant T of 0 was significant at the .05 level; therefore, the null hypothesis was rejected. For the public school group, the direction of change was that of improvement. In considering the Opportunity Center group, the resultant T of 4 was not significant at the .05 level;

therefore, the null hypothesis was not rejected. In terms of the change observed, the difference was not significant. For the State School group, the resultant T of 13 was not significant at the .05 level; therefore, the null hypothesis was not rejected. In summary, there was significant change in performance for the total group and for one sub-group, the public school group. There was no significant change in performance of two sub-groups, the Opportunity Center group and the State School group.

The Dvorine Pseudo-Isochromatic Plates, Section 2, were used to obtain an indication of the color perception of trainable mentally retarded children. Pronko, cited by Dvorine (13), found that color vision followed the usual developmental patterns associated with learning and maturation. It was hypothesized that there would be an increase in the color perception ability of trainable mentally retarded children over time and with maturation. Data were subjected to the McNemar test for significance of changes. Since the alternative hypothesis specified the direction of the predicted difference, the region of rejection consisted of all values of chi square which were so large that they had a probability associated with their occurrence under the null hypothesis of .05 or less. Inasmuch as the probability under the null hypothesis associated with the occurrence observed was $p < .001$ and was less than .05 level of significance, the observed value of chi square was in the region of rejection and the decision was to reject the null hypothesis. It was concluded that the experimental group of trainable mentally retarded children showed a significant tendency to manifest an increase in color perception over time and with maturation.

The ten tachistoscopically presented tests of visual efficiency were tests which used modified targets, targets from commercially available standardized tests, and which used constructed targets, targets which were designed specifically for this study. Table 7 consists of the results of the comparison of performance on each of the tests with that of the Snellen E, which was treated as the independent variable.

The Snellen E and the Sjogren, pretest, right and left eyes, indicated a correlation of .94 and .86, respectively. Each correlation was significant at the .01 level which required .515 or greater correlation. Post-tests yielded a correlation of .88 and .98 for right and left eyes. Level of significance was at the .01 level for both correlations. The Snellen E and the Kindergarten Chart were significantly correlated at the .01 level. Right eye, pretest correlation was .70; left eye, pretest correlation was .77; right eye, post-test correlation was .68; and left eye, post-test correlation was .69. The modified test correlating Keystone Preschool test targets with the Snellen E indicated correlation at the .01 level of significance. Correlation

TABLE 7

CORRELATION BETWEEN SERIES II, TACHISTOSCOPIC TESTS, SNELLEN E TEST WITH SJOGREN, KINDERGARTEN CHART, VISUAL ACHIEVEMENT, KEYSTONE PRIMARY, M/C 1, M/C 2, M/C 3, M/C 4, AND M/C 5, RIGHT EYE PRETESTS, LEFT EYE PRETESTS, RIGHT EYE POST-TESTS, AND LEFT EYE POST-TESTS

Test Compared With Snellen E	Eye	Correlation	Significance[a]
Sjogren, Pretest	Right	.94	.01
Sjogren, Pretest	Left	.86	.01
Sjogren, Post-test	Right	.88	.01
Sjogren, Post-test	Left	.98	.01
Kindergarten, Pretest	Right	.70	.01
Kindergarten, Pretest	Left	.77	.01
Kindergarten, Post-test	Right	.68	.01
Kindergarten, Post-test	Left	.70	.01
Keystone Preschool, Pretest	Right	.62	.01
Keystone Preschool, Pretest	Left	.87	.01
Keystone Preschool, Post-test	Right	.53	.01
Keystone Preschool, Post-test	Left	.62	.01
Visual Achievement, Pretest	Right	.84	.01
Visual Achievement, Pretest	Left	.84	.01
Visual Achievement, Post-test	Right	.79	.01
Visual Achievement, Post-test	Left	.79	.01

TABLE 7--Continued

Test Compared With Snellen E	Eye	Correlation	Significance[a]
M/C 1, Pretest	Right	.76	.01
M/C 1, Pretest	Left	.87	.01
M/C 1, Post-test	Right	.85	.01
M/C 1, Post-test	Left	.90	.01
M/C 2, Pretest	Right	.61	.01
M/C 2, Pretest	Left	.88	.01
M/C 2, Post-test	Right	.73	.01
M/C 2, Post-test	Left	.82	.01
M/C 3, Pretest	Right	.69	.01
M/C 3, Pretest	Left	.70	.01
M/C 3, Post-test	Right	.80	.01
M/C 3, Post-test	Left	.81	.01
M/C 4, Pretest	Right	.59	.01
M/C 4, Pretest	Left	.58	.01
M/C 4, Post-test	Right	.58	.01
M/C 4, Post-test	Left	.79	.01
M/C 5, Pretest	Right	.77	.01
M/C 5, Pretest	Left	.73	.01
M/C 5, Post-test	Right	.63	.01
M/C 5, Post-test	Left	.79	.01

[a] With 22 df, r of .515 or better required for significance of .01.

coefficients were: pretest, right eye, .62; pretest, left eye, .87; post-test, right eye, .53; and post-test, left eye, .62. The Snellen E and the Visual Achievement Forms yielded a correlation of .84, pretest, left eye; .79, post-test, right eye; and .79, post-test, left eye.

Each was significantly correlated at the .01 level. The Snellen E and the targets of M/C 1, which used black line drawings on white background, were correlated at the .01 level of significance. Pretests yielded a correlation of .76 and .87 for right eyes. Post-tests yielded a correlation of .85 and .90 for right and left eyes. The Snellen E and the targets of M/C 2, which used black silhouettes on white background, were correlated at the .01 level of significance. Right eye, pretest correlation was .61; left eye, pretest correlation was .88; right eye, post-test correlation was .73; and left eye, post-test correlation was .82. The Snellen E and the targets of M/C 3, which used white line drawings on black background, were significantly correlated at the .01 level. Correlation coefficients were: pretest, right eye, .66; pretest, left eye, .70; post-test, right eye, .80; and post-test, left eye, .81. The Snellen E and the targets of M/C 4, which used white silhouettes on black background, were correlated at the .01 level of significance. Pretests yielded a correlation of .58 and .57 for the right and left eyes. Post-test yielded a correlation of .58 and .79 for right and left eyes. The Snellen E and the targets of M/C 5, which used black line drawings on white background, with background in context, were correlated at the .01 level of significance. Right eye, pretest correlation was .77; left eye, pretest, correlation was .73; right eye, post-test, correlation was .63; and left eye, post-test, correlation was .79. In summary, each of the nine tests considered correlates with the Snellen E at the .01 level of significance, i.e., each test seems to be no better nor no worse than the Snellen E.

Each of the ten tests presented tachistoscopically was presented on a timed basis. Presentation time was in hundredths of a second, with the possibility of the child's responding correctly at .01 of a second, up to 1.00, a full second. There were three presentations of each target at each time setting, with failure being that a child's not being able to respond correctly from .01 at three presentations, in ascending .01 of a second through the presentation of the target at 1.00 for six presentations. Each response time was recorded for each of the five target sizes utilized by each test in Series II. The direction of the difference between the timed-scores of the Snellen E and the timed-scores on each of the nine tests compared with the Snellen E was not predicted. With the Wilcoxon matched-pairs signed-ranks test for small samples (N= 25 or less), the region of rejection consisted of all values of T which were so small that the probability associated with their occurrence under the null hypothesis was equal to or less than .05 level of significance for a two-tailed test. The data in Table 8 include the significances of differences between the timed-performances on the Snellen E and the timed-performances at the 20/20 target size on the Sjogren, Kindergarten Chart, Keystone

TABLE 8

SIGNIFICANCES OF DIFFERENCE[a] BETWEEN THE TIMED PERFORMANCES ON THE SNELLEN E AND THE TIMED PERFORMANCES AT THE 20/20 TARGET SIZE ON THE SJOGREN, KINDERGARTEN CHART, KEYSTONE PRESCHOOL, VISUAL ACHIEVEMENT, M/C 1, M/C 2, M/C 3, M/C 4, and M/C 5 MODIFIED AND CONSTRUCTED TESTS

Test Compared With Snellen E (E--up)	Target	T	Level of Significance
Sjogren:			
Right--Pretest	Hand--up	38.5	> .05 (.05 ≤ 29)
Left--Pretest		33.5	> .05 (.05 ≤ 21)
Right--Post-test		0	.01 (.01 ≤ 3)
Left--Post-test		2	.05 (.05 ≤ 3)
Kindergarten Chart:			
Right--Pretest	Heart	46	> .05 (.05 ≤ 25)
Left--Pretest		51.5	> .05 (.05 ≤ 21)
Right--Post-test		23.5	> .05 (.05 ≤ 10)
Left--Post-test		11.5	> .05 (.05 ≤ 3)
Keystone Preschool:			
Right--Pretest	House	66	> .05 (.05 ≤ 29)
Left--Pretest		25.5	> .05 (.05 ≤ 21)
Right--Post-test		24.5	> .05 (.05 ≤ 10)
Left--Post-test		23	> .05 (.05 ≤ 13)
Visual Achievement:			
Right--Pretest	Divided	41	> .05 (.05 ≤ 25)
Left--Pretest	Rectangle	34	> .05 (.05 ≤ 21)
Right--Post-tqst		33	> .05 (.05 ≤ 17)
Left--Post-test		28.5	> .05 (.05 ≤ 17)

TABLE 8--Continued

Test Compared With Snellen E (E--up)	Target	T	Level of Significance
M/C 1:			
Right--Pretest	Ball,	39.5	> .05 (.05 ≤ 25)
Left--Pretest	black line	39	> .05 (.05 ≤ 12)
Right--Post-test	on white	30	> .05 (.05 ≤ 10)
Left--Post-test		22.5	> .05 (.05 ≤ 8)
M/C 2:			
Right--Pretest	Ball,	57	> .05 (.05 ≤ 25)
Left--Pretest	black sil-	55	> .05 (.05 ≤ 21)
Right--Post-test	houette on	34.5	> .05 (.05 _ 10)
Left--Post-test	white	31.5	> .05 (.05 _ 10)
M/C 3:			
Right--Pretest	Ball,	43	> .05 (.05 ≤ 21)
Left--Pretest	white line	41.5	> .05 (.05 ≤ 21)
Right--Post-test	on black	19	> .05 (.05 ≤ 8)
Left--Post--test		10.5	> .05 (.05 ≤ 2)
M/C 4:			
Right--Pretest	Ball,	62	> .05 (.05 ≤ 34)
Left--Pretest	white sil-	25.5	> .05 (.05 ≤ 25)
Right--Post-test	houette on	30	> .05 (.05 ≤ 10)
Left--Post-test		15.5	> .05 (.05 ≤ 13)
M/C 5:			
Right--Pretest	Ball,	68	> .05 (.05 ≤ 29)
Left--Pretest	black line	72	> .05 (.05 ≤ 34)
Right--Post-test	on white in	16	> .05 (.05 ≤ 5)
Left--Post-test	context	16.5	> .05 (.05 ≤ 5)

[a] Wilcoxon matched-pairs signed-ranks, Siegel (75, pp. 75-79).

Preschool, Visual Achievement, M/C 1, M/C 2, M/C 3, M/C 4, and M/C 5 modified and constructed tests. The research hypothesis was that there would be a significant difference in timed-response scores between the Snellen E and the nine modified and constructed tests. With two exceptions, the decision was to reject the alternative hypothesis and accept the null hypothesis--that there was no significant difference between the timed-response scores of the Snellen E and the nine modified and constructed tests. The two exceptions were the right eye and left eye, post-test of the Sjogren Hand. In the case of the right eye, post-test, Sjogren Hand, 20/20 target size, the resultant $\underline{T}$ of zero was significant at the .01 level; therefore, the alternative hypothesis was accepted. For the left eye, post-test, the resultant $\underline{T}$ of 2 was significant at the .05 level, and the decision was to accept the alternative hypothesis. The two exceptions at the 20/20 target size, right and left eye, post-test of the Sjogren Hand, indicated significantly better timed-performance scores on the hand, fingers oriented up, than on the E, arms oriented up. On the basis of numbers and percentages, 34 of 36 sub-tests or 94% indicated no significant difference in performance on the hand than on the E. In the case of 2 of 36 subtests or 6%, there were significantly better timed-performance scores in the direction of the hand.

Information contained in Table 9 consists of the significances of difference between the timed-performances at the 20/20 target size on the Snellen E and the timed-performances on the Sjogren Hand, Kindergarten Chart, Keystone Preschool, Visual Achievement, M/C 1, M/C 2, M/C 3, M/C 4, and M/C 5 modified and constructed tests. The research hypothesis was that there would be a significant difference in the timed-response scores between the Snellen E and the nine modified and constructed tests. With five exceptions, the decision was to accept the null hypothesis--that there was no significant difference between the timed-response scores of the Snellen E and the nine modified and constructed tests. The five exceptions were right eye, pretest of the Sjogren; left eye, pretest and post-test of the Keystone Preschool; right eye, pretest, M/C 1; and left eye, post-test of M/C 2. In the case of the right eye, pretest, Sjogren, the resultant T of 20 was significant at the .05 level; therefore, the null hypothesis was rejected. For the left eye, pretest, Keystone Preschool, the resultant T was 33 and was significant at the .05 level. The decision was to reject the null hypothesis. The observed T of 8.5 for the left eye, post-test, Keystone Preschool, was significant at the .01 level; therefore, the decision was to reject the null hypothesis. The null hypothesis was rejected on the basis of the resultant T of 28.5 in the case of M/C 1, right eye, pretest, at the 20/20 target size. In the case of the left

TABLE 9

SIGNIFICANCES OF DIFFERENCE[a] BETWEEN THE TIMED PERFORMANCES OF THE SNELLEN E AND THE TIMED PERFORMANCES AT THE 20/20 TARGET SIZE ON THE SJOGREN, KINDERGARTEN CHART, KEYSTONE PRE-SCHOOL, VISUAL ACHIEVEMENT, M/C 1, M/C 2, M/C 3, M/C 4, and M/C 5 MODIFIED AND CONSTRUCTED TESTS

Test Compared With Snellen E (E--left)	Target	T	Significance
Sjogren:			
Right--Pretest	Hand--left	20	$.05 \; (.05 \le 29)$
Left--Pretest		50	$> .05 \; (.05 \le 34)$
Right--Post-test		18.5	$> .05 \; (.05 \le 13)$
Left--Post-test		14.5	$> .05 \; (.05 \le 8)$
Kindergarten Chart:			
Right--Pretest	Square	114.5	$> .05 \; (.05 \le 34)$
Left--Pretest		57.5	$> .05 \; (.05 \le 34)$
Right--Post-test		37	$> .05 \; (.05 \le 17)$
Left--Post-test		20.5	$> .05 \; (.05 \le 8)$
Keystone Preschool:			
Right--Pretest	Glass	62.5	$> .05 \; (.05 \le 40)$
Left--Pretest		33	$.05 \; (.05 \le 40)$
Right--Post-test		57.5	$> .05 \; (.05 \le 25)$
Left--Post-test		8.5	$.01 \; (.01 \le 9)$
Visual Achievement:			
Right--Pretest	Triangle	58	$> .05 \; (.05 \le 25)$
Left--Pretest		25	$> .05 \; (.05 \le 17)$
Right--Post-test		41	$> .05 \; (.05 \le 17)$
Left--Post-test		24	$> .05 \; (.05 \le 10)$

TABLE 9--Continued

Test Compared With Snellen E (E--left)	Target	T	Significance
M/C 1:			
Right--Pretest	Duck,	28.5	$.05$ $(.05 \le 34)$
Left--Pretest	black line	70	$>.05$ $(.05 \le 34)$
Right--Post-test	on white	33	$>.05$ $(.05 \le 13)$
Left--Post-test		17	$>.05$ $(.05 \le 5)$
M/C 2:			
Right--Pretest	Duck,	33.5	$>.05$ $(.05 \le 25)$
Left--Pretest	black sil-	50.5	$>.05$ $(.05 \le 29)$
Right--Post-test	houette on	40	$>.05$ $(.05 \le 21)$
Left--Post-test	white	14	$.05$ $(.05 \le 21)$
M/C 3:			
Right--Pretest	Duck,	56	$>.05$ $(.05 \le 29)$
Left--Pretest	white line	62.5	$>.05$ $(.05 \le 34)$
Right--Post-test	on black	28	$>.05$ $(.05 \le 17)$
Left--Post-test		21	$>.05$ $(.05 \le 13)$
M/C 4:			
Right--Pretest	Duck, white	92.5	$>.05$ $(.05 \le 40)$
Left--Pretest	silhouette	40.5	$>.05$ $(.05 \le 40)$
Right--Post-test	on black	26	$>.05$ $(.05 \le 21)$
Left--Post-test		28.5	$>.05$ $(.05 \le 21)$
M/C 5:			
Right--Pretest	Duck,	50.5	$>.05$ $(.05 \le 17)$
Left--Pretest	black line	60.5	$>.05$ $(.05 \le 40)$
Right--Post-test	on white	14	$>.05$ $(.05 \le 8)$
Left--Post-test	in context	16	$>.05$ $(.05 \le 8)$

[a] Wilcoxon matched-pairs signed-ranks test, Siegel (75, pp. 75-79).

eye, post-test of the M/C 2, the resultant T of 14 was significant at the .05 level. The decision was to reject the null hypothesis. On the basis of numbers and percentages, 31 of 36, or 86% of the sub-tests indicated no significant difference in performance between the E with arms oriented left and the hand with fingers oriented left, the square, glass, triangle, the duck, black line on white, and the duck, black silhouette on white. Five of 36 sub-test timed-performance scores, or 14%, indicated a significant difference between the E, arms oriented left, the Sjogren Hand, fingers oriented left, the Keystone Preschool glass, the duck in the five target-types used. The significantly better timed-performance scores were in the direction of the hand at the 20/20 target size, right eye, pretest; toward the E, left eye, pretest, over the Keystone glass; toward the glass, left eye, post-test over the E; toward the duck, black line on white, over the E, right eye, pretest; and toward the duck, black silhouette on white over the E, left eye, post-test.

The data included in Table 10 consists of the significances of difference between the timed-performances of the 20/50 target size on the Snellen E and the timed-performances on the Sjogren Hand, Kindergarten Chart, Keystone Preschool, Visual Achievement, M/C 1, M/C 2, M/C 3, M/C 4, and M/C 5 modified and constructed tests.

TABLE 10

SIGNIFICANCES OF DIFFERENCE[a] BETWEEN THE TIMED PERFORMANCES ON THE SNELLEN E AND THE TIMED PERFORMANCES AT THE 20/50 TARGET SIZE ON THE SJOGREN, KINDERGARTEN CHART, KEYSTONE PRE-SCHOOL, VISUAL ACHIEVEMENT, M/C 1, M/C 2, M/C 3, M/C 4, and M/C 5 MODIFIED AND CONSTRUCTED TESTS

Test Compared With Snellen E (E--right)	Target	T	Significance
Sjogren:			
Right--Pretest	Hand--right	55	> .05 (.05 ≤ 29)
Left--Pretest		13	.01 (.01 ≤ 19)
Right--Post-test		45	> .05 (.05 ≤ 21)
Left--Post-test		26	> .05 (.05 ≤ 10)
Kindergarten Chart:			
Right--Pretest	Cross	58	> .05 (.05 ≤ 34)
Left--Pretest		51	> .05 (.05 ≤ 25)
Right--Post-test		60.5	> .05 (.05 ≤ 25)
Left--Post-test		22.5	> .05 (.05 _ 10)
Keystone Preschool:			
Right--Pretest	Cat	53.8	> .05 (.05 < 46)
Left--Pretest		23.5	.05 (.05 ≤ 34)
Right--Post-test		51.5	> .05 (.05 ≤ 34)
Left--Post-test		31.5	> .05 (.05 ≤ 21)
Visual Achievement:			
Right--Pretest	Square	89	> .05 (.05 ≤ 46)
Left--Pretest		0	.01 (.01 ≤ 19)
Right--Post-test		38.5	> .05 (.05 ≤ 21)
Left--Post-test		49.5	> .05 (.05 ≤ 25)
M/C 1:			
Right--Pretest	Boat, black line on white	59	> .05 (.05 < 46)
Left--Pretest		60.5	> .05 (.05 ≤ 34)
Right--Post-test		41.5	> .05 (.05 ≤ 21)
Left--Post-test		20	> .05 (.05 ≤ 8)

TABLE 10--Continued

Test Compared With Snellen E (E--right)	Target	T	Significance
M/C 2:			
Right--Pretest	Boat, black	62	$> .05$ ($.05 \le 34$)
Left--Pretest	silhouette	37	$> .05$ ($.05 \le 34$)
Right--Post-test	on white	43	$> .05$ ($.05 \le 21$)
Left--Post-test		46	$> .05$ ($.05 \le 21$)
M/C 3:			
Right--Pretest	Boat,	78	$> .05$ ($.05 \le 40$)
Left--Pretest	white line	69	$> .05$ ($.05 \le 46$)
Right--Post-test	on black	43.5	$> .05$ ($.05 \le 21$)
Left--Post-test		29.5	$> .05$ ($.05 \le 21$)
M/C 4:			
Right--Pretest	Boat,	65	$> .05$ ($.05 \le 40$)
Left--Pretest	white sil-	30.5	$> .05$ ($.05 \le 46$)
Right--Post-test	houette on	67.5	$> .05$ ($.05 \le 29$)
Left--Post-test	black	32.5	$> .05$ ($.05 \le 17$)
M/C 5:			
Right--Pretest	Boat,	80	$> .05$ ($.05 \le$ [illegible]
Left--Pretest	black line	55	$> .05$ ($.05 \le 34$)
Right--Post-test	on white	41.5	$> .05$ ($.05 \le 13$)
Left--Post-test	in context	33	$> .05$ ($.05 \le 13$)

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[a] Wilcoxon matched-pairs signed-ranks tests, Siegel (75, pp. 75-79).

The research hypothesis was that there would be a significant difference in timed-response scores between the Snellen E and the nine modified and constructed tests. With three exceptions, the decision was not to reject the null hypothesis--that there was no significant difference between the timed-response scores of the Snellen E and the nine modified and constructed tests. The three exceptions were left eye, pretest of the Sjogren; left eye, pretest of the Keystone Preschool; and left eye, pretest, of the Visual Achievement. In the case of the left eye, pretest of the Sjogren, the resultant T of 13 was significant at the .01 level; therefore, the null hypothesis was rejected. For the left eye, pretest of the Keystone Preschool, the observed T of 23.5 was significant at the .05 level. The decision was to reject the null hypothesis. The observed T of zero for the left eye, pretest, Visual Achievement, was significant at the .01 level; therefore, the decision was to reject the null hypothesis. On the basis of numbers and percentages, 33 of 36 or 92% of the sub-tests indicated no significant difference in performance between the E with arms oriented right, and the hand with fingers oriented right, the cross, cat, square, boat in the five target-types used. Three of thirty-six timed-performance scores, or 8%, indicated a significant difference between the E with arms oriented right, the Sjogren Hand with fingers oriented right, the Keystone Preschool cat, and the Visual Achievement square. The significantly better timed-performance scores were in the direction of the hand at the 20/50 target size, left eye, pretest; toward the E, left eye, pretest, over Keystone Preschool cat; and toward the E, left eye, pretest, over the Visual Achievement square.

The information found in Table 11 consists of the significance of difference between the timed-performances at the 20/70 target size on the Snellen E and the timed-performances on the Sjogren, Kindergarten Chart, Keystone Preschool, Visual Achievement, M/C 1, M/C 2, M/C 3, M/C 4, and M/C 5 modified and constructed tests. The research hypothesis was that there would be a significant difference in timed-response scores between the Snellen E and the nine modified and constructed tests. With four exceptions, the decision was to accept the null hypothesis that there was no significant difference between the timed-response scores of the Snellen E and the nine modified and constructed tests. The exceptions were right eye, pretest of the Sjogren; right eye, post-test of the Kindergarten Chart; left eye, pretest of the Visual Achievement; and right eye, pretest of M/C 2. In the case of the right eye, pretest of the Sjogren Hand, the resultant T of 25.5 was significant at the .01 level; therefore, the null hypothesis was rejected. For the right eye, post-test of the Kindergarten Chart, the observed T of 12.5 was significant at the .01 level; therefore, the decision was to reject the null hypothesis. The observed T of 20.5 for the left eye, pretest, Visual Achievement, was significant at the .01 level. The decision was to reject the null hypothesis. For the right eye, pretest of M/C 2, the observed T of 42.5 was significant at the .05 level. The null hypothesis was rejected. From the consideration of numbers

TABLE 11

SIGNIFICANCES OF DIFFERENCE[a] BETWEEN THE TIMED PERFORMANCES OF THE SNELLEN E AND THE TIMED PERFORMANCES AT THE 20/70 TARGET SIZE ON THE SJOGREN, KINDERGARTEN CHART, KEYSTONE PRESCHOOL, VISUAL ACHIEVEMENT, M/C 1, M/C 2, M/C 3, M/C 4, AND M/C 5 MODIFIED AND CONSTRUCTED TESTS

Test Compared With Snellen E (E--down)	Target	T	Significance
Sjogren:			
Right--Pretest	Hand--down	25.5	.05 (.05 ≤ 34)
Left--Pretest		58	>.05 (.05 ≤ 40)
Right--Post-test		36	>.05 (.05 ≤ 17)
Left--Post-test		42	>.05 (.05 ≤ 21)
Kindergarten Chart:			
Right--Pretest	Circle	73.5	>.05 (.05 ≤ 34)
Left--Pretest		65	>.05 (.05 ≤ 46)
Right--Post-test		12.5	.05 (.05 ≤ 21)
Left--Post-test		53	>.05 (.05 ≤ 25)
Keystone Preschool:			
Right--Pretest	Rabbit	81	>.05 (.05 ≤ 46)
Left--Pretest		47.5	>.05 (.05 ≤ 34)
Right--Post-test		39	>.05 (.05 ≤ 21)
Left--Post-test		79	>.05 (.05 ≤ 29)
Visual Achievement:			
Right--Pretest	Cross	69	>.05 (.05 ≤ 40)
Left--Pretest		20.5	.01 (.01 ≤ 23)
Right--Post-test		62.5	>.05 (.05 ≤ 29)
Left--Post-test		22	>.05 (.05 ≤ 13)

TABLE 11--Continued

Test Compared With Snellen E (E--down)	Target	T	Significance
M/C 1:			
Right--Pretest	Fish, black	69	$> .05$ ($.05 \leq 40$)
Left--Pretest	line on white	49	$> .05$ ($.05 \leq 21$)
Right--Post-test		54.5	$> .05$ ($.05 \leq 0$)
Left--Post-test		40	$> .05$ ($.05 \leq 21$)
M/C 2:			
Right--Pretest	Fish, black	42.5	$.05$ ($.05 \leq 46$)
Left--Pretest	silhouette	87	$> .05$ ($.05 \leq 52$)
Right--Post-test	on white	24	$> .05$ ($.05 \leq 17$)
Left--Post-test		50.5	$> .05$ ($.05 \leq 21$)
M/C 3:			
Right--Pretest	Fish, white	71	$> .05$ ($.05 \leq 52$)
Left--Pretest	line on black	56.5	$> .05$ ($.05 \leq 40$)
Right--Post-test		41	$> .05$ ($.05 \leq 21$)
Left--Post-test		41	$> .05$ ($.05 \leq 21$)
M/C 4:			
Right--Pretest	Fish, white	53.5	$> .05$ ($.05 \leq 46$)
Left--Pretest	silhouette	58.5	$> .05$ ($.05 \leq 40$)
Right--Post-test	on black	67.7	$> .05$ ($.05 \leq 40$)
Left--Post-test		34.5	$> .05$ ($.05 \leq 34$)
M/C 5:			
Right--Pretest	Fish, black	93.5	$> .05$ ($.05 \leq 46$)
Left--Pretest	line on white	47	$> .05$ ($.05 \leq 46$)
Right--Post-test	in context	50	$> .05$ ($.05 \leq 21$)
Left--Post-test		46	$> .05$ ($.05 \leq 25$)

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[a] Wilcoxon matched-pairs signed-ranks test, Siegel (75, pp. 75-79).

and percentages, it was found that 32 of 36, or 89%, of the sub-tests indicated no significant difference in performance between the E with arms oriented down, and the hand with fingers oriented down, the circle, rabbit, cross, and fish in the five target-types used. Four of thirty-six timed-performance scores, or 11%, indicated a significant difference between the E with arms oriented down, the Sjogren Hand with fingers oriented down, the circle of the Kindergarten Chart, the cross of the Visual Achievement, and the fish, black silhouette on white, of the M/C 2. The significantly better timed-performance scores were in the direction of the E at the 20/70 target size, right eye, pretest, Sjogren; toward the E over the circle of the Kindergarten Chart, right eye, post-test; toward the E over the cross of the Visual Achievement, left eye, pretest; and toward the E over the fish, black silhouette on white, of the M/C 2.

The data presented in Table 12 include the significances of difference between the timed-performances on the Snellen E and the timed-performances at the 20/200 target size on the Sjogren Hand, Kindergarten Chart, Keystone Preschool, Visual Achievement, M/C 1, M/C 2, M/C 3, M/C 4, and M/C 5 modified and constructed tests.

TABLE 12

SIGNIFICANCES OF DIFFERENCE[a] BETWEEN THE TIMED PERFORMANCES OF THE SNELLEN E AND THE TIMED PERFORMANCES AT THE 20/200 TARGET SIZE ON THE SJOGREN, KINDERGARTEN CHART, KEYSTONE PRESCHOOL, VISUAL ACHIEVEMENT, M/C 1, M/C 2, M/C 3, M/C 4, AND M/C 5 MODIFIED AND CONSTRUCTED TESTS

Test Compared With Snellen E (E--up)	Target	T	Significance
Sjogren:			
Right--Pretest	Hand--up	33.5	$> .05$ ($.05 \leq 29$)
Left--Pretest		48.5	$> .05$ ($.05 \leq 25$)
Right--Post-test		61.5	$> .05$ ($.05 \leq 17$)
Left--Post-test		45	$> .05$ ($.05 \leq 21$)
Kindergarten Chart:			
Right--Pretest	Boat	108.5	$> .05$ ($.05 \leq 46$)
Left--Pretest		98	$> .05$ ($.05 \leq 52$)
Right--Post-test		49.5	$> .05$ ($.05 \leq 21$)
Left--Post-test		40	$> .05$ ($.05 \leq 29$)
Keystone Preschool:			
Right--Pretest	Rooster	70.5	$> .05$ ($.05 \leq 34$)
Left--Pretest		48	$> .05$ ($.05 \leq 40$)
Right--Post-test		55.5	$> .05$ ($.05 \leq 40$)
Left--Post-test		54	$> .05$ ($.05 \leq 34$)
Visual Achievement:			
Right--Pretest	Circle	52	$> .05$ ($.05 \leq 34$)
Left--Pretest		47	$> .05$ ($.05 \leq 25$)
Right--Post-test		52	$> .05$ ($.05 \leq 34$)
Left--Post-test		54	$> .05$ ($.05 \leq 34$)
M/C 1:			
Right--Pretest	Bus, black	31	$.01$ ($.01 \leq 32$)
Left--Pretest	line on	29.5	$> .05$ ($.05 \leq 29$)
Right--Post-test	white	50.2	$> .05$ ($.05 \leq 34$)
Left--Post-test		41.5	$> .05$ ($.05 \leq 21$)

TABLE 12--Continued

Test Compared With Snellen E (E--up)	Target	T	Significance
M/C 2:			
Right--Pretest	Bus, black	79	> .05 (.05 ≤ 40)
Left--Pretest	silhouette	56.5	> .05 (.05 ≤ 29)
Right--Post-test	on white	45.9	> .05 (.05 ≤ 34)
Left--Post-test		50	> .05 (.05 ≤ 21)
M/C 3:			
Right--Pretest	Bus, white	115	> .05 (.05 ≤ 52)
Left--Pretest	line on	71.5	> .05 (.05 ≤ 52)
Right--Post-test	black	52	> .05 (.05 ≤ 29)
Left--Post-test		65	> .05 (.05 ≤ 29)
M/C 4:			
Right--Pretest	Bus, white	90.5	> .05 (.05 ≤ 46)
Left--Pretest	silhouette	106	> .05 (.05 ≤ 46)
Right--Post-test	on black	96	> .05 (.05 ≤ 46)
Left--Post-test		87.5	> .05 (.05 ≤ 52)
M/C 5:			
Right--Pretest	Bus, black	67.5	> .05 (.05 ≤ 46)
Left--Pretest	line on white	68	> .05 (.05 ≤ 52)
Right--Post-test	in context	69	> .05 (.05 ≤ 40)
Left--Post-test		44.5	> .05 (.05 ≤ 21)

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[a] Wilcoxon matched-pairs signed-ranks test, Siegel (75, pp. 75-79).

With one exception the decision was to accept the null hypothesis--that there was no significant difference between the timed-response scores of the Snellen E and the nine modified and constructed tests. The one exception was the right eye, pretest of M/C 1, which yielded a T of 31 which was significant at the .01 level. The null hypothesis was rejected. The significantly better timed-performance scores were in the direction of the bus, black line on white, of M/C 1, over the E with the arms oriented up. Thirty-five of thirty-six sub-tests, or 97%, indicated no significant difference in the performance between the E with arms oriented up, and the Sjogren Hand with fingers oriented up, the boat of the Kindergarten Chart, the rooster of the Keystone Pre-school, the circle of the Visual Achievement, and the bus in the five target-types used. One of thirty-six timed-performance scores, or 3%, indicated a significance difference between the E with the arms up and the bus, black line on white, of M/C 1. The significantly better timed-performance score was in the direction of the bus, black line on white, over the E.

Correlation coefficients were computed to determine the relationship of the pretest with the post-test of each test included in Series II. The data included in Table 13 presents the correlation and level of significance for each of the modified and constructed tests of Series II, pretest and post-test.

TABLE 13

CORRELATION AND LEVEL OF SIGNIFICANCE OF CORRELATION BETWEEN SERIES II, PRETEST AND POST-TEST

Test	Eye	Correlation	Significance[a]
Snellen E	Right	.7140	.01
Snellen E	Left	.6474	.01
Sjogren Hand	Right	.5286	.01
Sjogren Hand	Left	.5410	.01
Kindergarten Chart	Right	.3530	> .05
Kindergarten Chart	Left	.6536	.01
Visual Achievement	Right	.7916	.01
Visual Achievement	Left	.7895	.01
Keystone Preschool	Right	.4349	.05
Keystone Preschool	Left	.4545	.05
M/C 1	Right	.7582	.01
M/C 1	Left	.4763	.02
M/C 2	Right	.6523	.01
M/C 2	Left	.6887	.01
M/C 3	Right	.5647	.01
M/C 3	Left	.4516	.05
M/C 4	Right	.6327	.01
M/C 4	Left	.7258	.01
M/C 5	Right	.5790	.01
M/C 5	Left	.6217	.01

[a] With 22 df, r of .515 required for .01 level, r of .402 required for .02 level, and r of .404 required for .05 level of significance.

With two exceptions, pretests, right eye, were correlated with post-tests, right eye, at the .01 level of significance. The Keystone Preschool pretest and post-test correlation, right eye, was at the .05 level of significance. Pretest and post-test, right eye, Kindergarten Chart, were not significantly correlated. The Wilcoxon matched-pairs signed-ranks test was applied to the above data, which were not significantly correlated, to determine the difference. Since the direction of the difference was not predicted, a two-tailed region of rejection was appropriate. The region of rejection consisted of all values of T which were so small that the probability associated with their occurrence under the null hypothesis was equal to or less than .05 level of significance for a two-tailed test. The resultant T of 56.5 was not significant; therefore, the null hypothesis--that the two tests were not significantly different--was accepted. The conclusion was that the pretest and post-test, right eye, of the Kindergarten Chart were not significantly different at the .05 level. Pretest and post-test of M/C 1 were significantly correlated at the .02 level for the left eye. Pretest and post-tests of M/C 3 and Keystone Preschool, left eye, were correlated at the .05 level of significance.

Information contained in Table 14 consists of the correlation and level of significance of correlation between the four Series I and Series II tests which used the same visual targets.

TABLE 14

CORRELATION AND LEVEL OF SIGNIFICANCE OF CORRELATION BETWEEN FOUR SERIES I COMMERCIALLY AVAILABLE TESTS, AMERICAN OPTICAL ILLITERATE E, SJOGREN TEST, AMERICAN OPTICAL KINDERGARTEN TEST, AND KEYSTONE PRESCHOOL TEST, AND SERIES II TESTS WHICH USED THE SAME VISUAL TARGETS, SNELLEN E, SJOGREN, KINDERGARTEN CHART, AND KEYSTONE PRESCHOOL

Tests and Series	Eye	Correlation	Significance[a]
Snellen E:			
Pretest I--Pretest II	Right	.4218	.05
Pretest I--Pretest II	Left	.4255	.05
Post-test I--Post-test II	Right	.2338	> .05
Post-test I--Post-test II	Left	.2516	> .05
Sjogren:			
Pretest I--Pretest II	Right	.1538	> .05
Pretest I--Pretest II	Left	.3516	> .05
Post-test I--Post-test II	Right	.1976	> .05
Post-test I--Post-test II	Left	.3064	> .05
Kindergarten:			
Pretest I--Pretest II	Right	.2152	> .05
Pretest I--Pretest II	Left	.1288	> .05
Post-test I--Post-test II	Right	.1754	> .05
Post-test I--Post-test II	Left	.2877	> .05
Keystone Preschool:			
Pretest I--Pretest II	Right	.3511	> .05
Pretest I--Pretest II	Left	.2678	> .05
Post-test I--Post-test II	Right	.2894	> .05
Post-test I--Post-test II	Left	.3354	> .05

[a] With 21 df.

Series I pretest of a given target-type was correlated with Series II pretest of the same target-type, i.e., American Optical Illiterate E, Series I, was correlated with the Snellen E, Series II, as each used the identical visual target-type. Two research hypotheses were involved. Those hypotheses were (A) if the group performance were significantly lower on Series II, tachistoscopically presented targets, perception would be the discrepancy; and (B) if the group performance were significantly lower on the tests of Series I, commercially available tests of visual acuity, the difference could be attributed to training. The null hypothesis was that if the performance on the two series, Series I and Series II, were equal, the two factors, visual acuity and perception, were equivalent. Two sub-tests were correlated at the .05 level of significance. Those were Pretest I and Pretest II, right eye, and Pretest I and Pretest II, left eye.

To determine the significance of differences between the four Series I and Series II tests which used the same visual targets and which were not correlated at the .05 level of significance, Wilcoxon matched-pairs signed ranks tests were computed. The data in Table 15 consist of significances of difference between the American Optical Illiterate E, a commercially available test of Series I, and the Snellen E, a modified/constructed test of Series II, for the total group: the school groups--public school, Opportunity Center, State School, and for the neurologic groups--non-mongoloid, neurologic defect, mongoloid, neurologically normal, and mongoloid, neurologically abnormal. Since the direction of difference was not predicted, a two-tailed region of rejection was appropriate. The region of rejection consisted of all values of T which were so small that the probability associated with their occurrence under the null hypothesis was equal to or less than the .05 level of significance for a two-tailed test. The Pretest I and Pretest II tests, right and left eyes, were significantly correlated at the .05 level; therefore, Wilcoxon tests were computed for Post-test I and Post-test II data. For the total group, the three school groups and the three neurologic groups, the values of T, for both right and left eyes, were so large that the probability associated with their occurrence under the null hypothesis was greater than the .05 level of significance for a two-tailed test. In each instance, the decision was not to reject the null hypothesis. The conclusion was that there was no significant difference between the two

TABLE 15

SIGNIFICANCES OF DIFFERENCE[a] BETWEEN THE AMERICAN OPTICAL ILLITERATE E, SERIES I, COMMERCIALLY AVAILABLE TEST, AND SNELLEN E, SERIES II MODIFIED/CONSTRUCTED TEST, FOR THE TOTAL GROUP, SCHOOL GROUPS, AND NEUROLOGIC GROUPS

Group	Eye	T	Significance
Total Group			
Post-test I--Post-test II	Right	111.5	> .05 (.05 ≤ 58)
Post-test I--Post-test II	Left	84.5	> .05 (.05 ≤ 52)
School Groups			
Public School:			
Post-test I--Post-test II	Right	13	> .05 (.05 ≤ 2)
Post-test I--Post-test II	Left	13	> .05 (.05 ≤ 2)
Opportunity Center:			
Post-test I--Post-test II	Right	4.5	> .05 (.05 ≤ 2)
Post-test I--Post-test II	Left	3	> .05 (.05 ≤ 2)
State School:			
Post-test I--Post-test II	Right	7	> .05 (.05 ≤ 2)
Post-test I--Post-test II	Left	6.5	> .05 (.05 ≤ 0)
Neurologic Groups			
Non-mongoloid, neurologic defect:			
Post-test I--Post-test II	Right	46.5	> .05 (.05 ≤ 13)
Post-test I--Post-test II	Left	27	> .05 (.05 ≤ 10)
Mongoloid, neurologically normal:			
Post-test I--Post-test II	Right	7.5	> .05 (.10 ≤ 0)
Post-test I--Post-test II	Left	4.5	> .05 (.10 ≤ 0)

TABLE 15--Continued

Group	Eye	T	Significance
Mongoloid, neurologically abnormal:			
Post-test I--Post-test II	Right	2	$> .05$ ($.20 \leq 0$)
Post-test I--Post-test II	Left	2.5	$> .05$ ($.20 \leq 0$)

[a] Wilcoxon matched-pairs signed-ranks test, Siegel (75, pp. 75-79).

factors, visual acuity and perception, when the American Optical Illiterate E and the Snellen E were considered.

The information found in Table 16 consists of the significance of difference between the Sjogren Test, a commercially available test of Series I, and the Sjogren Hand, a modified/constructed test of Series II, for the total group, the school groups, public school, Opportunity Center, and State School, and for the neurologic groups, non-mongoloid, neurologic defect, mongoloid, neurologically normal, and mongoloid, neurologically abnormal. Since the direction of difference was not predicted, a two-tailed region of rejection was appropriate for the Wilcoxon matched-groups paired-ranks test used with the data. As with the data included in Table 15, two research hypotheses were involved. Those hypotheses were (A) if the group performance were

TABLE 16

SIGNIFICANCES OF DIFFERENCE[a] BETWEEN THE SJOGREN TEST, SERIES I, COMMERCIALLY AVAILABLE TEST, AND SJOGREN, SERIES II, MODIFIED/CONSTRUCTED TEST, FOR THE TOTAL GROUP, SCHOOL GROUPS, AND NEUROLOGIC GROUPS

Group	Eye	T	Significance
Total Group			
Pretest I--Pretest II	Right	35	$.05\ (.05 \le 46)$
Pretest I--Pretest II	Left		$.05\ (.05 \le 34)$
Post-test I--Post-test II	Right	51.5	$>.05\ (.05 \le 34)$
Post-test I--Post-test II	Left	109	$>.05\ (.05 \le 52)$
School Groups			
Public School:			
Pretest I--Pretest II	Right	7	$>.05\ (.05 \le 2)$
Pretest I--Pretest II	Left	0	$.05\ (.05 \le 2)$
Post-test I--Post-test II	Right	7.5	$>.05\ (.05 \le 0)$
Post-test I--Post-test II	Left	12	$>.05\ (.05 \le 3)$
Opportunity Center:			
Pretest I--Pretest II	Right	6	$>.05\ (.05 \le 0)$
Pretest I--Pretest II	Left	6	$>.05\ (.05 \le 0)$
Post-test I--Post-test II	Right	9	$>.05\ (.05 \le 2)$
Post-test I--Post-test II	Left	14	$>.05\ (.05 \le 2)$
State School:			
Pretest I--Pretest II	Right	0	$>.05\ (.10 \le 0)$
Pretest I--Pretest II	Left	4	$>.05\ (.20 \le 0)$
Post-test I--Post-test II	Right	3.5	$>.05\ (.20 \le 0)$
Post-test I--Post-test II	Left	2	$>.05\ (.10 \le 0)$
Neurologic Groups			
Non-mongoloid, neurologic defect:			
Pretest I--Pretest II	Right	0	$.01\ (.01 \le 5)$
Pretest I--Pretest II	Left	11	$>.05\ (.05\ \_\ 10)$
Post-test I--Post-test II	Right	33.5	$>.05\ (.05\ \_\ 10)$
Post-test I--Post-test II	Left	37.5	$>.05\ (.05\ \_\ 13)$

TABLE 16--Continued

Group	Eye	T	Significance
Neurologic Groups (cont.)			
Mongoloid, neurologically normal:			
Pretest I--Pretest II	Right	3	$> .05$ ($.20 \leq 0$)
Pretest I--Pretest II	Left	4	$> .05$ ($.20 \leq 0$)
Post-test I--Post-test II	Right	1.5	$> .05$[b]
Post-test I--Post-test II	Left	4.5	$> .05$ ($.10 \leq 0$)
Mongoloid, neurologically abnormal:			
Pretest I--Pretest II	Right	0	$> .05$[b]
Pretest I--Pretest II	Left	3	$> .05$[b]
Post-test I--Post-test II	Right		$> .05$[b]
Post-test I--Post-test II	Left		$> .05$[b]

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[a] Wilcoxon matched-pairs signed-ranks test, Siegel (75, pp. 75-79).

[b] Table does not give values for significance below an N = 4.

significantly lower on Series II, tachistoscopically presented targets, perception would be the discrepancy; and (B) if the group performance were significantly lower on the tests of Series I, commercially available tests of visual acuity, the difference could be attributed to training.

The region of rejection consisted of all values of T which were so small that the probability associated with their occurrence under the null hypothesis was equal to or less than .05 level of significance for a two-tailed test. In the case of the right eye, total group, Pretest I--Pretest II, the resultant T of 35 was significant at the .05 level; therefore, the null hypothesis was rejected. The significantly better scores were in the direction of Pretest II. It was concluded that since the group performance was significantly lower on Pretest I, the commercially available test of visual acuity, the difference could be attributed to training. For the left eye, Pretest I--Pretest II, the observed T of 33.5 was significant at the .05 level. As with Pretest I--Pretest II, right eye, above, the null hypothesis was rejected, concluding that the difference could be attributed to training. The observed T of zero for the left eye, Pretest I--Pretest II, public school group, was significant at the .05 level; therefore, the null hypothesis was rejected. The direction of significant improvement was toward Pretest II; therefore, it was concluded that the difference could be attributed to training. For the non-mongoloid, neurologic defect, the resultant T of zero for right eye, Pretest I--Pretest II, was significant at the .01 level. The decision was to reject the null hypothesis. The direction of improvement favored Pretest II; therefore, it was concluded that the difference could be attributed to training. For the remainder of the groups, the values of T, for both right and left eyes, were so large that the probability associated with their occurrence under the null hypothesis was greater than .05 level of significance for a two-tailed test. For those tests, the decision was not to reject the null hypothesis, that there was no significant difference between the two factors, visual acuity and perception, when the Sjogren Test, Series I, and the Sjogren, Series II, were considered. On the basis of the significant difference for the total group, it was concluded that training resulted in better performance scores for the Sjogren targets.

The data included in Table 17 consist of the significances of difference between the American Optical Kindergarten Test, a commercially available test of visual acuity of Series I, and the Kindergarten Chart, a modified/constructed test of Series II, for the total group, the school groups, public school, Opportunity Center, State School, and for the neurologic groups, non-mongoloid, neurologic defect, mongoloid, neurologically normal, and mongoloid, neurologically abnormal. A two-tailed region of rejection was appropriate for the Wilcoxon test used with the data since the direction of difference was not predicted. As with data included in Tables 16 and 17, two research hypotheses were involved. Those hypotheses were (A) if the group performance were significantly lower on Series II, tachistoscopically presented targets, perception would be the

TABLE 17

SIGNIFICANCES OF DIFFERENCE[a] BETWEEN THE AMERICAN OPTICAL KINDERGARTEN TEST, SERIES II, COMMERCIALLY AVAILABLE TEST, AND KINDERGARTEN CHART, SERIES II, MODIFIED/CONSTRUCTED TEST, FOR THE TOTAL GROUP, SCHOOL GROUPS, AND NEUROLOGIC GROUPS

Group	Eye	T	Significance
Total Group			
Pretest I--Pretest II	Right	39	.05 (.05 ≤ 46)
Pretest I--Pretest II	Left	21	.01 (.01 ≤ 37)
Post-test I--Post-test II	Right	100	> .05 (.05 ≤ 58)
Post-test I--Post-test II	Left	126	> .05 (.05 ≤ 52)
School Groups			
Public School:			
Pretest I--Pretest II	Right	8	> .05 (.05 ≤ 3)
Pretest I--Pretest II	Left	8	> .05 (.05 ≤ 3)
Post-test I--Post-test II	Right	15	> .05 (.05 ≤ 3)
Post-test I--Post-test II	Left	4.5	> .05 (.05 ≤ 2)
Opportunity Center:			
Pretest I--Pretest II	Right	6	> .05 (.05 ≤ 0)
Pretest I--Pretest II	Left	0	.05 (.05 ≤ 0)
Post-test I--Post-test II	Right	5.5	> .05 (.05 ≤ 0)
Post-test I--Post-test II	Left	13	> .05 (.05 ≤ 2)
State School:			
Pretest I--Pretest II	Right	1.5	> .05 (.10 ≤ 0)
Pretest I--Pretest II	Left	.5	> .05 (.05 ≤ 0)
Post-test I--Post-test II	Right	11	> .05 (.05 ≤ 2)
Post-test I--Post-test II	Left	7	> .05 (.05 ≤ 0)
Neurologic Groups			
Non-mongoloid, neurologic defect:			
Pretest I--Pretest II	Right	1.5	.01 (.01 ≤ 3)
Pretest I--Pretest II	Left	1.5	.01 (.01 ≤ 7)
Post-test I--Post-test II	Right	34	> .05 (.05 ≤ 17)
Post-test I--Post-test II	Left	29.5	> .05 (.05 ≤ 13)

TABLE 17--Continued

Group	Eye	T	Significance
Neurologic Groups (cont.)			
Mongoloid, neurologically normal:			
Pretest I--Pretest II	Right	6	> .05 (.10 ≤ 0)
Pretest I--Pretest II	Left	4	> .05 (.20 ≤ 0)
Post-test I--Post-test II	Right	1	> .05 (.20 ≤ 0)
Post-test I--Post-test II	Left	0	> .05 (.10 ≤ 0)
Mongoloid, neurologically abnormal:			
Pretest I--Pretest II	Right	0	> .05 (.20 _ 0)
Pretest I--Pretest II	Left	0	> .05 (.20 _ 0)
Post-test I--Post-test II	Right	3	> .05 (.20 _ 0)
Post-test I--Post-test II	Left	1.5	> .05[b]

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[a] Wilcoxon matched-pairs signed-ranks test, Siegel (75, pp. 75-79).

[b] Table does not give values for significance below an N= 4.

discrepancy; and (B) if group performance were significantly lower on the tests of Series I, commercially available tests of visual acuity, the difference could be attributed to training. The region of rejection consisted of all values of T which were so small that the probability associated with their occurrence under the null hypothesis was equal to or less than .05 level of significance for a two-tailed test. In the case of the total group, right eye, Pretest I and Pretest II, the resultant T of 39 was significant at the .05 level. The null hypothesis was rejected. The significantly better scores were in the direction of Pretest II. For the left eye, Pretest I and Pretest II, total group, the observed T of 21 was significant at the .01 level. The null hypothesis was rejected. The significantly better scores were in the direction of the Pretest II. It was concluded that the difference seen in performance scores of both eyes, Pretest I and Pretest II, could be attributed to training. The observed T of zero for the left eye, Pretest I and Pretest II, Opportunity Center group, was significant at the .05 level; therefore, the null hypothesis was rejected. The direction of significant improvement was toward Pretest II; therefore, it was concluded that the difference could be attributed to training. For the non-mongoloid, neurologic defect, the resultant T's of 1.5 for both right and left eyes, Pretest I and Pretest II, were significant at the .01 level. The decision was to reject the null hypothesis. The direction of improvement, for both eyes, was toward Pretest II. The conclusion was that the differences could be attributed to training. For the remainder of the groups, the values of T, for both right and left eyes, were so large that the probability associated with their occurrence under the null hypothesis was greater than .05 level of significance for a two-tailed test. For those tests, the decision was not to reject the null hypothesis, that there was no significant difference between the two factors, visual acuity and perception, when the American Optical Kindergarten Test, Series I, and the Kindergarten Chart, Series II, were considered. On the basis of the significant difference for the total group, it was concluded that training resulted in better performance scores for the Kindergarten targets. There was evidence that non-mongoloid children with neurologic defects did significantly better on Pretest II after having been exposed to Pretest I.

The data included in Table 18 consist of the significances of difference between the Keystone Preschool Test, a commercially available test of visual acuity of Series I, and the Keystone Preschool, a modified/constructed test of Series II, for the total group, the school groups--public school, Opportunity Center, State School, and for the neurologic groups--non-mongoloid, neurologic defect, mongoloid, neurologically normal, and mongoloid, neurologically abnormal. A two-tailed region of rejection was appropriated for the Wilcoxon test used with the data as the direction of difference was not predicted. The region of rejection consisted of all values of $\underline{T}$ which were so small that the probability associated with their occurrence under the null hypothesis was equal to or less than .05 level of significance for a two-tailed test. In the case of the total group, Pretest I and Pretest II, right and left eyes, and Post-test I and Post-test II, right and left eyes, performance scores indicated significantly better scores

TABLE 18

SIGNIFICANCES OF DIFFERENCE[a] BETWEEN THE KEYSTONE PRESCHOOL TEST, SERIES I, COMMERCIALLY AVAILABLE TEST, AND KEYSTONE PRESCHOOL, SERIES II, MODIFIED/CONSTRUCTED TEST, FOR THE TOTAL GROUP, SCHOOL GROUPS, AND NEUROLOGIC GROUPS

Group	Eye	T	Significance
Total Group			
Pretest I--Pretest II	Right	22.5	$.01\ (.01 \leq 32)$
Pretest I--Pretest II	Left	20	$.01\ (.01 \leq 37)$
Post-test I--Post-test II	Right	16	$.01\ (.01 \leq 23)$
Post-test I--Post-test II	Left	17	$.01\ (.01 \leq 27)$
School Groups			
Public School:			
Pretest I--Pretest II	Right	6	$> .05\ (.05 \leq 0)$
Pretest I--Pretest II	Left	0	$.05\ (.05 \leq 2)$
Post-test I--Post-test II	Right	0	$.05\ (.05 \leq 0)$
Post-test I--Post-test II	Left	0	$.05\ (.05 \leq 2)$
Opportunity Center:			
Pretest I--Pretest II	Right	0	$.05\ (.05 \leq 0)$
Pretest I--Pretest II	Left	1	$> .05\ (.10 \leq 0)$
Post-test I--Post-test II	Right	0	$> .05\ (.20 \leq 0)$
Post-test I--Post-test II	Left	0	$> .05\ (.10 \leq 0)$
State School:			
Pretest I--Pretest II	Right	1	$.05\ (.05 \leq 2)$
Pretest I--Pretest II	Left	13	$> .05\ (.05 \leq 2)$
Post-test I--Post-test II	Right	6	$> .05\ (.05 \leq 2)$
Post-test I--Post-test II	Left	6	$> .05\ (.05 \leq 2)$
Neurologic Groups			
Non-mongoloid, neurologic defect:			
Pretest I--Pretest II	Right	16	$.05\ (.05 \leq 17)$
Pretest I--Pretest II	Left	12	$.05\ (.05 \leq 17)$
Post-test I--Post-test II	Right	12	$.05\ (.05 \leq 17)$
Post-test I--Post-test II	Left	12	$> .05\ (.05 \leq 10)$

TABLE 18--Continued

Group	Eye	T	Significance
Neurologic Groups (cont.)			
Mongoloid, neurologically normal:			
Pretest I--Pretest II	Right	0	$> .05^{b}$
Pretest I--Pretest II	Left	0	$> .05^{b}$
Post-test I--Post-test II	Right	0	$> .05^{b}$
Post-test I--Post-test II	Left	6	$> .05^{b}$
Mongoloid, neurologically abnormal:			
Pretest I--Pretest II	Right	0	$> .05^{b}$
Pretest I--Pretest II	Left	1	$> .05$ ($.20 \leq 0$)
Post-test I--Post-test II	Right	0	$> .05^{b}$
Post-test I--Post-test II	Left	6	$> .05^{b}$

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[a] Wilcoxon matched-pairs signed-ranks test, Siegel (75, pp. 75-79).

[b] Table does not give values for significance below an N= 4.

in the direction of the Keystone Preschool, Series II, the modified test. The resultant $\underline{T}$'s, 22.5, 20, 16, and 17, were significant at the .01 level. The null hypothesis was rejected for the total group, both eyes, Pretest I and Pretest II and Post-test I and Post-test II. For the public school group, observed $\underline{T}$'s of zero were significant at the .05 level for left eye, Pretest I and Pretest II and for both eyes, Post-test I and Post-test II. The decision was to reject the null hypothesis. Direction of better performance favored Series II. The resultant T's of zero and one, right eye, Pretest I and Pretest II, for Opportunity School group and State School group respectively, were significant at the .05 level. The null hypothesis was rejected for each group. Observed T's of 16, 12, 12, Pretest I and Pretest II, right and left eyes, and Post-test I and Post-test II, right eye, were significant at the .01 level. Again, the null hypothesis was rejected. It was concluded that the difference could be attributed to training, since the direction of significant improvement was toward the modified test. For the remainder of the groups, the values of T were so large that the probability associated with their occurrence under the null hypothesis was greater than .05 level of significance for a two-tailed test. For those tests, the decision was not to reject the null hypothesis, that there was no significant difference between the two factors, visual acuity and perception, when the Keystone Preschool Test, Series I, was compared with the Keystone Preschool, Series II. On the basis of the significant difference for the total group, it was concluded that training resulted in better performance scores for the Keystone Preschool targets. There was evidence that non-mongoloid children with neurologic defects did significantly better on Pretest II after having been subjected to the test situation for Series I. The neurologic groups, mongoloid, neurologically normal, and mongoloid, neurologically abnormal, exhibited n's, which when corrected for ties, were not included on the table for values of T.

Comparison of Screening Findings With Ophthalmological (Clinical) Findings

The results of the St. Louis Study, as reported by Crane, Foote, Scobee, and Green (82) seemed to indicate that the best measure of the efficiency of a screening procedure was its agreement with the ophthalmologist's clinical findings. One factor considered was the standard for referral, as that had direct bearing upon the proportions of correct and incorrect referrals. Leverett (36), indicated that errors of under-referral and of over-referral were expected in the screening of children of normal intelligence. Steps taken to reduce one factor tend to increase the other. It is important that both under-referral and over-referral be considered in a comparison of screening findings with clinical findings. In the comparison of screening findings with ophthalmological (clinical) findings, the failing criteria for the study were outlined by the examining ophthalmologist. As outlined by Barkley (92), the criteria were as follows:

VISUAL ACUITY:

a. Mild, up to 20/40
b. Moderately Severe: 20/40 to 20/100
c. Severe: above 20/100 visual loss

MUSCLES:

Deviation of three (3) prism diopters, in the vertical plane only, and eight (8) prism diopters or greater in lateral deviations.

HYPEROPIA:

a. Mild: + 3.00 diopters or less
b. Moderate: +3.00 diopters to +6.00 diopters
c. Severe: above +6.00 diopters

MYOPIA:

a. Mild: -1.00 diopter to -2.00 diopters
b. Moderately Severe: -.200 diopters to -4.00 diopters
c. Severe: above -4.00 diopters

ASTIGMATISM:

a. Mild: 0 to +1.00 or -1.00 diopter
b. Moderately Severe: above -1.00 to -2.00 diopters, and above +1.00 diopters to +2.00 diopters
c. Severe: above -2.00 diopters or above +2.00 diopters

Referral criterion for VISUAL ACUITY would include those whose visual acuity is less than 20/30

The data presented in Table 19 and Table 20 are intended as an overview of the percentages of correct referrals, over-referrals, and under-referrals on the tests of visual acuity and tests of muscle deviation which were included in Series I. Specific identification as to number and percentage for each category--correctly referred, needed care; correctly not referred; over-referred; under-referred--is presented in Appendix D.

The data included in Table 19 consist of a comparison of referrals by commercially available tests, on the basis of failure of the 20/30 visual acuity line, with clinical ophthalmological findings. The Sjogren, post-test, correctly referred the greatest percentage of children, 84%. That same post-test under-referred no children but over-referred 16% of the children tested. The Sjogren, pre-test, correctly referred 73%, over-referred 23%, and under-referred 4%. The pretest of the American Optical Illiterate E correctly referred 73% of the children screened, over-referred 27%, and under-referred no children. The Plus Sphere, Part 2A, of the Massachusetts Vision Test, post-test, correctly referred 76%, over-referred 12%, and under-referred 12% of the children screened. The pretest of the American Optical Kindergarten Test correctly referred 69% of the children screened, and over-referred 31% of the children screened. The post-test of the same test, the American Optical Kindergarten Test, correctly referred 68% of the children screened but over-referred 32%. The post-test of the American Optical Illiterate E correctly referred 68% and under-referred 32% of the children screened. The pretest, Plus Sphere, correctly referred 58% of the children screened, over-referred 12%, and under-referred 31%.

Information contained in Table 20 consists of a comparison of referrals on the basis of positive clinical findings of muscular involvement by the ophthalmologist.

TABLE 19

COMPARISON OF REFERRALS ON BASIS OF FAILURE OF 20/30 VISUAL ACUITY LINE, ON COMMERCIALLY AVAILABLE TESTS WITH OPHTHALMOLOGICAL (CLINICAL) FINDINGS

Test	Correct Referral Percentage	Over-Referral Percentage	Under-Referral Percentage
Sjogren, Post-test	84	16	
Sjogren, Pretest	73	23	4
Snellen E, Pretest	73	27	
Plus Sphere,[a] Post-test	76	12	12
American Optical Kindergarten, Pretest	69	31	
American Optical Kindergarten, Post-test	68	32	
Snellen E, Post-test	68	32	
Plus Sphere,[a] Pretest	58	12	31

[a] Part 2A, Massachusetts Vision Test

TABLE 20

COMPARISON OF REFERRALS ON BASIS OF POSITIVE CLINICAL FINDINGS OF MUSCULAR INVOLVEMENT BY OPHTHALMOLOGIST

Test	Correct Referral Percentage	Over-Referral Percentage	Under-Referral Percentage
Maddox Rod, Part 4B, Near Phoria, Post-test	84		16
Allied Muscle Balance, Post-test	76	12	12
Maddox Rod,[a] Test 4A, Distant Phoria, Post-test	72	12	16
Maddox Rod,[a] Test 4B, Near Phoria, Pretest	72	12	16
Maddox Rod,[a] Test 3, Distant Phoria, Pretest	69	27	4
Maddox Rod,[a] Test 3, Distant Phoria, Post-test	68	16	16
Maddox Rod,[a] Test 4A, Distant Phoria, Pretest	65	23	12
Allied Muscle Balance, Pretest	58	38	4

[a] Massachusetts Vision Test

Two tests were used--the Massachusetts Vision Test, Test 3, distant phoria, vertical, Test 4A, distant phoria, horizontal, and Test 4B, near phoria, horizontal--and the Allied Muscle Balance Test. Tests 3, 4A, and 4B of the Massachusetts Vision Test commonly are referred to as Maddox Rod tests. The Maddox Rod, Test 4B, near phoria, post-test, correctly referred 84% of the children screened and under-referred 16%. The post-test of the Allied Muscle Balance Test correctly referred 76% of the children tested, over-referred 12%, and under-referred 12%. The Maddox Rod, Test 4A, distant phoria, horizontal, pretest, correctly referred 72%, over-referred 12%, and under-referred 16% of the children screened. The Maddox Rod, Test 3, distant phoria, vertical, pretest, correctly referred 69% of the children screened, over-referred 27%, and under-referred 4%. The Maddox Rod, Test 3, distant phoria, vertical, post-test, correctly referred 68%, over-referred 16%, and under-referred 16%. The Maddox Rod, Test 4, distant phoria, horizontal, post-test, correctly referred 65%, over-referred 23%, and under-referred 12% of the children screened. The pretest of the Allied Muscle Balance correctly referred 58% of the children screened, over-referred 38%, and under-referred 4%.

The data presented in Table 21 are a summary of referral by Plus Sphere, Test 2, Massachusetts Vision Test, the Sjogren Test, the American Optical Illiterate E, and the American Optical Kindergarten

TABLE 21

SUMMARY OF REFERRAL BY PLUS SPHERE (PART 2, MASSACHUSETTS VISION TEST), SJOGREN, AMERICAN OPTICAL KINDERGARTEN, AMERICAN OPTICAL ILLITERATE E, SERIES I PRETESTS AND POST-TESTS, COMPARED WITH OPHTHALMOLOGICAL FINDINGS OF CORRECTLY REFERRED, CORRECTLY NOT REFERRED, OVER-REFERRED, AND UNDER-REFERRED

	Plus Sphere	Sjogren	American Optical Kindergarten	American Optical Illiterate E
	Number & Percentage	Number & Percentage	Number & Percentage	Number & Percentage
Total Correctly Referred	17 74	16 67	14 58	14 58
Correctly not Referred	9 39	5 21	3 13	3 13
Correctly Referred, Acuity Deviation	8 35	11 46	11 46	11 46
Total Incorrectly Referred	6 26	8 33	10 42	10 42
Over-Referred	4 17	8 33	10 42	10 42
Under-Referred	2 9	None	None	None

Test, Series I, pretests and post-tests, compared with ophthalmological findings of correctly referred, correctly not referred, over-referred, and under-referred. The Plus Sphere correctly referred seventeen, 74%, of the children. The Sjogren gave the next highest number of correct referrals, 16 or 67%, with the Illiterate E and Kindergarten Test each referring fourteen, 58%, correctly. The Plus Sphere gave the fewest incorrect referrals, six or 26%, followed by the Sjogren, eight or 33%, and with ten or 42% incorrect referrals for the Illiterate E and the Kindergarten Test. On the basis of not referring children who should not have been referred, the Plus Sphere correctly passed nine or 39% of the children screened. The Sjogren correctly did not refer five children, 21%, and the Illiterate E and Kindergarten Test correctly did not refer three children, or 13% of those screened. The Sjogren, Illiterate E, and Kindergarten Test each correctly referred eleven children, 46%, who were found to have acuity problems on the basis of clinical judgment. The Plus Sphere correctly referred eight children, 35%, who were found to be in need of ophthalmologic care. The Illiterate E and the Kindergarten Test, each with ten children, 42%, listed as over-referred, yielded the largest number and percentage of over-referrals. The Sjogren yielded the next highest number and percentage of over-referrals, eight children, or 33% of the children screened. The fewest number and percentage of over-referrals was indicated by the Plus Sphere Test, four or 17%. No children were under-referred by the Sjogren, Illiterate E, and Kindergarten Test. Two children, 9% of the children screened, were under-referred on the basis of comparison with clinical judgment.

Table 22 consists of a summary of referral by the Maddox Rod Tests, Tests 3, 4A, 4B, of the Massachusetts Vision Test, Series I, pretest and post-test, and the Allied Muscle Balance Test, Series I, pretest and post-test, compared with positive findings of muscle deviation by the ophthalmologist on the basis of correctly referred, correctly not referred, over-referred, and under-referred. Test 4B, near phoria, horizontal, correctly referred seventeen children, 74%; of those seventeen children, fourteen, 61%, were correctly not referred, and three children, 13%, were correctly referred, having muscle deviations. Test 4B over-referred three children, 13%, and under-referred the same number, three, or 13%. Test 3, distant phoria, vertical, and Test 4A, distant phoria, horizontal, sub-tests of the Massachusetts Vision Test, and the Allied Muscle Balance Test each was a test for distant phoria; therefore, the three could be compared, each with the other, as well as with clinical judgment. Test 3 gave the largest number of correct referrals, sixteen or 69%. Of the sixteen children correctly referred, eleven or 48% were correctly not referred, and five, 22%, were correctly referred, having muscle

TABLE 22

SUMMARY OF REFERRAL BY THE MADDOX ROD TEST, TESTS 3, 4A, 4B, OF THE MASSACHUSETTS VISION TEST, SERIES I, PRETEST AND POST-TEST, AND THE ALLIED MUSCLE BALANCE TEST, SERIES I, PRETEST AND POST-TEST, COMPARED WITH POSITIVE FINDINGS OF MUSCLE DEVIATION BY OPHTHALMOLOGIST ON THE BASIS OF CORRECTLY REFERRED, CORRECTLY NOT REFERRED, OVER-REFERRED, UNDER-REFERRED

	Maddox Rod Test of Massachusetts Vision Test			Allied Muscle Balance Test
	Test 3 Number & Percentage	Test 4A Number & Percentage	Test 4B Number & Percentage	Number & Percentage
Total Correctly Referred	16 70	15 65	17 74	13 57
Correctly Not Referred	11 48	12 52	14 61	8 35
Correctly Referred, Muscle Deviation	5 22	3 13	3 13	5 22
Total Incorrectly Referred	7 30	8 35	6 26	10 43
Over-Referred	6 26	5 22	3 13	9 39
Under-Referred	1 4	3 13	3 13	1 4

deviations. Test 4A correctly referred fifteen children, 65%. Of those fifteen, twelve children, 52%, were correctly not referred and three children, 13%, were correctly referred, having muscle deviations. The Allied Muscle Balance Test correctly referred thirteen children, 57%. Eight of the thirteen children, 35%, were correctly not referred and five, 22%, were correctly referred, having muscle deviations. The Allied Muscle Balance Test incorrectly referred the largest number of children, ten or 43%. Test 4A incorrectly referred eight children, 35%, and Test 3 incorrectly referred seven children, or 30%. The Allied Muscle Balance Test over-referred nine children, 39%; while Test 3 over-referred six, 26%, and Test 4A over-referred five, or 22%. Test 4A gave the largest number of under-referrals, three children, 13%, while Test 3 and the Allied Muscle Balance Test each under-referred one child, or 4% of the children screened.

The data presented in Table 23 are intended as an overview of the percentages of correct referrals, over-referrals, and under-referrals of the tachistoscopically presented modified/constructed tests of Series II. The pretest of M/C 2 yielded the largest percentage of correct referrals, 78%. The post-test of M/C 4 and the pretest of the Sjogren Hand each correctly referred 74% of the children screened. M/C 5, post-test, and M/C 1, pretest, and M/C 3, post-test, each correctly referred 70% of the children screened. M/C 5, post-test,

TABLE 23

COMPARISON OF REFERRAL BY TACHISTOSCOPICALLY PRESENTED MODIFIED AND CONSTRUCTED TARGETS FAILED AT 20/30 VISUAL ACUITY LINE ON PRETEST AND POST-TESTS WITH OPHTHALMOLOGICAL (CLINICAL) FINDINGS

Test	Correct Referral Percentage	Over-Referral Percentage	Under-Referral Percentage
M/C 2, Pretest	78	13	9
M/C 4, Post-test	74	17	9
Sjogren Hand, Pretest	74	4	22
M/C 5, Post-test	70	17	13
M/C 1, Pretest	70	13	17
M/C 3, Post-test	70	26	9
M/C 5, Post-test	65	26	9
Kindergarten Chart, Post-test	65	26	9
M/C 1, Post-test	65	22	13
Visual Achievement, Pretest	65	17	17
Snellen E, Pretest	65	9	26
M/C 4, Pretest	61	30	13
M/C 3, Pretest	61	26	13
Snellen E, Post-test	61	22	17
Sjogren Hand, Post-test	61	21	17
M/C 2, Post-test	57	30	13
Visual Achievement, Post-test	57	26	17

TABLE 23--Continued

Test	Correct Referral Percentage	Over-Referral Percentage	Under-Referral Percentage
Kindergarten Chart, Pretest	57	22	22
Keystone Preschool, Pretest	57	26	17
Keystone Preschool, Post-test	52	26	22

Kindergarten Chart, post-test, M/C 1, post-test, Visual Achievement, pretest, and Snellen E, pretest, each correctly referred 65% of the children screened. M/C 4, pretest, M/C 3, pretest, Snellen E, post-test, and Sjogren Hand, post-test, each correctly referred 61% of the children screened. M/C 2, post-test, Visual Achievement, post-test, Kindergarten Chart, pretest, and the Keystone Preschool, pretest, each correctly referred 57% of the children screened. The post-test of the Keystone Preschool yielded the smallest percentage of correct referrals, 52%. The Sjogren Hand, pretest, yielded the fewest over-referrals, 4%. The next fewest over-referrals were 9% by the Snellen E, pretest. M/C 2, pretest, and M/C 1, pretest, each yielded 13%

over-referral. There were 17% over-referrals by M/C 4, post-test, M/C 5, post-test, and by Visual Achievement, pretest. The post-test of the Sjogren Hand yielded 21% over-referral. M/C 1, post-test, Snellen E, post-test, and Kindergarten Chart, pretest, each yielded 22% over-referral. Seven tests yielded 26% over-referral. Those tests were the pretest and post-test of M/C 3, the pretest and post-test of the Keystone Preschool, and the post-tests of M/C 5, Kindergarten Chart, and Visual Achievement. The pretest, M/C 4, and the post-test of M/C 2 yielded the greatest percentage of over-referral, 30%. The Snellen E, pretest, yielded the largest percentages of under-referrals, 26%. The Sjogren Hand, pretest, M/C 1, pretest, Keystone Preschool, post-test, and the Kindergarten Chart, each yielded 22% over-referral. Five tests yielded 17% over-referral. Those tests were the pretest and post-test of the Visual Achievement, the pretest of the Keystone Preschool, and the post-tests of the Snellen E and the Sjogren Hand. The pretests of M/C 3 and M/C 4 and the post-tests of M/C 1, M/C 2, and M/C 5 resulted in 13% over-referral. The fewest over-referrals, 9%, resulted from screening with the pretest of M/C 2, and from screening with the post-tests of M/C 3, M/C 4, M/C 5, and the Kindergarten Chart.

The information contained in Table 24 is a summary of the referrals by the tachistoscopically presented modified/constructed tests of

TABLE 24--Part 1

SUMMARY OF REFERRAL BY TACHISTOSCOPICALLY PRESENTED MODIFIED AND CONSTRUCTED TESTS: SJOGREN HAND, M/C 5, M/C 3, M/C 1, SNELLEN E, M/C 4, M/C 2, KINDERGARTEN CHART, KEYSTONE PRESCHOOL, AND VISUAL ACHIEVEMENT, SERIES II, PRETESTS AND POST-TESTS, COMPARED WITH OPHTHALMOLOGICAL FINDINGS OF CORRECTLY REFERRED, CORRECTLY NOT REFERRED, OVER-REFERRED, AND UNDER-REFERRED

	Sjogren Hand	M/C 5	M/C 3	M/C 1	Snellen E
	Number & Percentage	Number & Percentage	Number & Percentage	Number & Percentage	Number & Percentage
Total Correctly Referred	17 74	15 65	15 65	15 65	15 65
Correctly Not Referred	10 43	7 31	7 30	8 35	7 30
Correctly Referred, Acuity Deviation	7 39	8 35	8 35	7 30	8 35
Total Incorrectly Referred	6 26	8 35	8 35	8 35	8 35
Over-Referred	4 17	6 26	6 26	5 22	6 26
Under-Referred	2 9	2 9	2 9	3 13	2 9

TABLE 24--Part 2

	M/C 4 Number & Percentage	M/C 2 Number & Percentage	Kindergarten Chart Number & Percentage	Keystone Preschool Number & Percentage	Visual Achievement Number & Percentage
Total Correctly Referred	14 61	14 61	14 61	13 57	11 48
Correctly Not Referred	6 26	6 26	5 22	6 26	5 22
Correctly Referred, Acuity Deviation	8 35	8 35	9 39	7 30	6 26
Total Incorrectly Referred	9 39	9 39	9 39	10 43	12 52
Over-Referred	7 30	7 30	8 35	7 30	8 35
Under-Referred	2 9	2 9	1 4	3 13	4 17

Series II: Sjogren Hand, M/C 5, M/C 3, M/C 1, Snellen E, M/C 4, M/C 2, Kindergarten Chart, Keystone Preschool, and Visual Achievement. Tests were discussed in the order of rank according to the greatest number and percentage of correct referrals. Referrals were compared with clinical ophthalmological findings of correctly referred, correctly not referred, over-referred, and under-referred. The Sjogren Hand referred seventeen children, 74%, correctly. Fifteen children, 65%, were correctly referred by each of the tests, M/C 5, M/C 3, M/C 1, and the Snellen E. Each of three tests, M/C 4, M/C 2, and the Kindergarten Chart, correctly referred fourteen children or 61% of the children screened. Thirteen children, 57%, were correctly referred by the Keystone Preschool. Eleven children, 48%, were correctly referred by the Visual Achievement. The greatest number and percentage of children not needing referral were yielded by screening results of the Sjogren Hand, which indicated ten children or 43%. Eight children, 35%, were correctly not referred by M/C 1. Seven children, 30%, were correctly not referred by each of the following tests: M/C 3, M/C 5, and Snellen E. Six children, 26%, were correctly not referred by each of the tests, M/C 2, M/C 4, and Keystone Preschool. The Kindergarten Chart and the Visual Achievement each correctly did not refer five children, or 22% of the children screened. The greatest number and percentage of acuity deviations were yielded by the Kindergarten Chart which indicated nine children or 39% of the children screened. Each of the tests, M/C 2, M/C 3, M/C 4, M/C 5, and Snellen E, referred eight children, or 35%, who were found to have acuity deviations. The greatest number of incorrectly referred children were yielded by results of the Visual Achievement, which incorrectly referred twelve children, or 52% of the children screened. The next highest number and percentage of incorrect referrals were on the basis of findings from the Keystone Preschool. Ten children, 43%, were incorrectly referred by the Keystone Preschool. Nine children, 39%, were incorrectly referred by the Kindergarten Chart, M/C 2, and M/C 4. Eight children, 35%, were incorrectly referred by M/C 1, M/C 3, M/C 5, and the Snellen E. The smallest number and percentage of incorrect referrals were yielded by the Sjogren Hand, which incorrectly referred six children or 26% of the children screened. The greatest number and percentage of over-referrals were indicated by the Visual Achievement and the Kindergarten Chart. Seven children, 30%, were over-referred on the basis of findings from the Keystone Preschool, M/C 2, and M/C 4. Six children, 26%, were over-referred on the basis of findings from M/C 3, M/C 5, and the Snellen E. Five children, or 22%, were over-referred on the basis of findings from M/C 1. The fewest over-referrals were the result of screening findings from the Sjogren Hand which over-referred four children, or 17% of the children screened. The fewest under-referrals were the result of screening findings from the Kindergarten Chart, one child or 4%. Six tests each under-referred two children, 9% of the children screened. Those tests were the Sjogren Hand, M/C 2, M/C 3, M/C 4, M/C 5, and Snellen E. The Keystone Preschool and M/C 1 each under-referred three children or 13% of the children screened. Four children, 17%, were under-referred by the Visual Achievement.

Discussion of Results

It was necessary that both over-referral and under-referral be considered in any comparison of screening findings with clinical judgment. In considering the necessity for eliminating under-referral, where possible, the position of this study was that it was better for a child to be over-referred, i.e., referred for professional care and found not to be in need of that care, than it was for a child not to be referred when that child was in need of professional care. Discussion of referral implications is divided into two parts, Series I, commercially available tests, and Series II, modified/constructed tests.

Series I, commercially available tests. The Sjogren, American Optical Kindergarten, and Keystone Preschool Tests were significantly correlated with the American Optical Illiterate E (Snellen Test Chart). Such correlation was necessary, for, according to Guiber (93), the Snellen Test Chart ". . . is the most scientific method for determining vision." Correlation of the Sjogren and American Optical Illiterate E either was significant or it was found, applying the Wilcoxon test, that there was no significant difference between the two tests. The Sjogren and Keystone Preschool Test were significantly different. The American Optical Kindergarten Test and the Keystone Preschool Test were significantly correlated.

The correlation and significance of correlation between the pretest and post-test performance on the American Optical Illiterate E, Sjogren, American Optical Kindergarten Test, and the Keystone Preschool Test was considered. In each case, the pretest and post-test were correlated at the .01 level of significance. It was concluded that training did not make a significant difference on any of those tests of visual acuity of Series I. A further conclusion was that administration of any one of those four tests, when standardized procedures for administration were adhered to, could be expected to yield results which would be significant on a pretest and post-test basis when used with trainable children in a non-clinical environment.

Two tests which screened for muscle deviation were included in Series I. Those tests were the Allied Muscle Balance Test and the Massachusetts Vision Test, Tests 3, 4A, and 4B. Treatment of data indicated that the group's performances on those tests were equal.

On consideration of the correlation and significance of correlation between the pretest and post-test performances on Tests 3, 4A, and 4B of the Massachusetts Vision Test, the findings were that the sub-tests were not significantly correlated. When significances of change between the pretest and post-test performances were computed, using the Binomial test, the decision was to reject the null hypothesis, that there was no significant difference between the pretest and post-test performances which was due to training and/or maturation. The conclusion was that either training and/or maturation resulted in a significant difference in pretest and post-test performances on the sub-tests of the Massachusetts Vision Test which screened for muscle deviation. For the Allied Muscle Balance Test, the conclusion was that there was no significant difference between pretest performance and post-test performance. The eye-hand coordination required to perform satisfactorily on the Allied Muscle Balance Test was not a prerequisite for satisfactory performance on the sub-tests of the Massachusetts Vision Test which screened for muscle deviation; therefore, although the group's performances were equal on the two instruments, consideration should be given when using the Allied Muscle Balance Test with children who manifest motor handicaps.

When subjected to the Wilcoxon test, performance data of the Visual Achievement Forms indicated that, for the total group, form perception of trainable mentally retarded children, in terms of copying ability, differed over time. The direction of change was that of improvement. When performance of the public school sub-group was considered, the direction of change was that of improvement; however, the sub-group performance of the State School and Opportunity Center groups indicated that for those groups, form perception, in terms of copying ability, did not differ over time. A possible explanation for those findings was that the public school group was the youngest group of children, when considered at chronological and mental age levels.

Pretest and post-test performance data of the Dvorine Pseudo-Isochromatic Plates, Section 2, were subjected to the McNemar test for significance of changes. It was found that the experimental group of trainable mentally retarded children showed a significant tendency to manifest an increase in color perception over time and with maturation.

On the premise that it was better to over-refer a child than to under-refer a child, for Series I, tests of visual acuity, the screening findings of the Sjogren, when compared with clinical judgment, yielded the highest number and percentage of correct referrals, sixteen children or 67% of the children screened and the lowest number and percentage of children incorrectly referred, eight children or 33%. The American Optical Illiterate E and the American Optical Kindergarten

Chart yielded identical numbers and percentages of correctly referred and incorrectly referred children, fourteen, 58%, and ten, 42%. There were no children who were under-referred by either of the above tests--Sjogren, American Optical Illiterate E, and American Optical Kindergarten Test. The Plus Sphere Test, Test 2 of the Massachusetts Vision Test, under-referred two children, 9% of the children screened. Considering over-referral, the Plus Sphere Test over-referred only half as many children as did the Sjogren. There seems to be some basis, when considering those results, for including a test of the nature of the Plus Sphere in the battery of screening tests administered to the trainable mentally retarded child.

Consideration of muscle deviation in retarded children is an important factor. Comparison of screening findings with clinical judgment indicated that Tests 3, 4A, and 4B of the Massachusetts Vision Test correctly referred a larger number and percentage of children than did the Allied Muscle Balance Test. The Massachusetts Vision Test, Tests 3, 4A, and 4B, incorrectly referred fewer children; however, Tests 4A and 4B tended to under-refer more children than did Test 3 and the Allied Muscle Balance Test. Because of the design of the Maddox Rod Tests, 3, 4A, 4B, of the Massachusetts Vision Test--three tests instead of the one test of the Allied Muscle Balance Test, more specific screening resulted. It was concluded that the eye-hand coordination required for satisfactory performance on the Allied Muscle Balance Test was a factor to be considered as a possible cause of over-referral.

On the basis of the above discussions--considering that the Sjogren correlated significantly with the Illiterate E, that the pretest and post-test performances were correlated at the .01 level of significance, that it yielded the highest number and percentage of correct referrals when screening findings were compared with clinical judgment of the ophthalmologist, and that there were no under-referrals--the Sjogren was the single test which yielded the best screening findings. It should be noted, however, that the American Optical Illiterate E and the American Optical Kindergarten Test each yielded results which compared favorably with those yielded by the Sjogren.

Series II, modified/constructed tests. Correlation coefficients were computed to determine the correlation and significance of correlation between the four Series I tests and Series II tests which used the same visual targets. Those tests were: Sjogren and Sjogren Hand, American Optical Kindergarten Test and Kindergarten Chart, American Optical Illiterate E and Snellen E, and Keystone Preschool Test and Keystone Preschool. Two research hypotheses were involved. Those hypotheses were: (A) if the group performance were significantly lower on the tests of Series II, tachistoscopically presented targets, perception would be the discrepancy; and (B) if the group performance were significantly lower on the tests of Series I, commercially available tests of visual acuity, the difference could be attributed to training. The null hypothesis was that performances on the two series, Series I and Series II, were equal, i.e., not significantly different, and that the two factors, visual acuity and perception, were equivalent. In each instance, the decision was not to reject the null hypothesis, or to reject the null hypothesis in the direction of hypothesis (B), with treatment of data indicating that the difference could be attributed to training. In no instance did treatment of data indicate that perception was the discrepancy.

The direction of the difference between the timed-scores on the Snellen E and the timed-scores on each of the nine tests compared with the Snellen E was considered. Data were subjected to the Wilcoxon test for small samples, i.e., an N of 25 or less. The null hypothesis tested was that there would not be a significant difference in the timed-response scores between the Snellen E and the nine modified/constructed tests. When the 20/20 target size was considered, 34 of 36 sub-tests, 94%, indicated no significant difference in performance. In the case of 2 of 36 sub-tests, 6%, there were significantly better timed-performance scores in the direction of the hand, fingers oriented up. Consideration of the 20/30 target size indicated that 31 of 36, 86%, of the sub-tests indicated no significant difference in performance. Five of thirty-six sub-test timed-performance scores, 14%, indicated a significant difference between the E, arms oriented left, the glass of the Keystone Preschool, the duck, black line on white, of M/C 1, and the duck, black silhouette on white, of M/C 2. At the 20/30 target size, the significantly better timed-performance scores were in the direction of the hand over the E, E over the glass, glass over the E, and toward the ducks of M/C 1 and M/C 2 over the E. Thirty-three of thirty-six, 92%, of the 20/50 target size sub-tests indicated no significant difference in performance between the E with the arms oriented right, the cross, the cat, the square, the boats, black line on white and black silhouette on white. Three of thirty-six timed-performance scores, 8%, indicated a significant difference in performance between the E with the arms oriented right, the cross, the cat, the square, the boat, black line on white, and the boat, black silhouette on white. Three of thirty-six timed-performance scores, 8%, indicated a significant difference between the E with arms oriented right, the Sjogren Hand with fingers oriented right, the cat of the Keystone Preschool, and the square of the Visual Achievement. The significantly better timed-performance scores were in the direction of the hand over the E, toward the E over the cat, and toward the E over the square. Four of thirty-six timed-performance scores, 11%, of the 20/70 target sub-tests indicated a significant difference between the E with arms oriented down, the Sjogren Hand with fingers oriented down, the circle of the Kindergarten Chart, the cross of the Visual Achievement, and the fish, black silhouette on white, of the M/C 2. The significantly better timed-performance scores were in the direction of the E over the Sjogren Hand, 20/70 target; toward the E over the circle of the Kindergarten Chart; toward the E over the cross of the Visual Achievement; and toward the E over the fish, black silhouette on white, of the M/C 2. In reference to the 20/200 target, only one of 36 timed-performance scores, 3%, indicated a significant difference between the E with arms oriented up and the bus, black line on white, of the M/C 1. The significantly better timed-performance score was in the direction of the bus over the E.

Each of the nine modified/constructed tests was significantly correlated with the tachistoscopically presented Snellen E. In each of the five target sizes, 20/20, 20/30, 20/50, 20/70, and 20/200, there [illegible] four, and one exception respectively where there was a significant difference between the timed response scores of the Snellen E and one or more of the nine modified/constructed tests. The above noted exceptions should be considered in any follow-up or standardizing study using data contained in this study.

There was no significant difference between the pretest and post-test performances of the ten modified/constructed tests of Series II. Treatment of data also indicated no significant difference between the factors, visual acuity and perception, in 78% of the cases which used the same visual targets. Those tests considered were Sjogren and Sjogren Hand, American Optical Kindergarten Test and Kindergarten Chart, American Optical Illiterate E and Snellen E, and the Keystone Preschool Test and Keystone Preschool from Series I and Series II batteries. For 22% of the cases, the difference between Series I and Series II batteries was attributed to training, i.e., the group performance was significantly lower on tests of Series I, commercially available tests, than on Series II, tachistoscopically presented modified/constructed tests.

As with Series I tests of visual acuity, on the premise that it was better to over-refer a child than to under-refer a child, considering Series II test of visual efficiency, the screening findings of the Sjogren Hand, when compared with clinical judgment, [illegible] the highest number and percentage of correct referrals, seventeen children or 74% of the children screened, and the lowest number and percentage of children incorrectly referred, six children or 26%. Four tests, the Snellen E, M/C 1, M/C 3, and M/C 5, each correctly referred fifteen children, 65%, and incorrectly referred eight, 35%, of the children screened. Three of the above tests, Snellen E, M/C 3, and M/C 5, along with the Sjogren Hand, each under-referred two children, 9% of the children screened. M/C 1 under-referred three children, 13% of the children screened.

On the basis of the foregoing discussion of findings regarding tests of Series II, the Sjogren Hand was the single test which yielded the largest number and percentage of correct referrals when compared with clinical judgment. Those findings indicated that the Sjogren Hand was significantly correlated with the Snellen E, that the pretest and post-test performances were correlated at the .01 level of significance, and that there were no under-referrals.

Three tests, the Snellen E, M/C 3, and M/C 5, each correctly referred fifteen children, 65%, and incorrectly referred eight, 35%, of the children screened. Those tests, along with the Sjogren Hand, each under-referred two children or 9% of the children screened. The Snellen E, M/C 3, and M/C 5 each correctly referred and incorrectly referred an identical number and percentage of children; therefore, each of the three gave results which compared favorably with results yielded by the Sjogren Hand.

CHAPTER V

SUMMARY AND RECOMMENDATIONS

Summary

This study was designed to investigate systematically (1) the performance of the trainable child on commercially available test instruments designed to determine visual acuity and muscle deviation; (2) the kinds of perceptual behavior which were observed when pictures, figures, silhouettes, or letters were presented tachistoscopically for varying lengths of time; (3) the extent to which commercially available tests of visual acuity and of muscle deviation and the extent to which modified/constructed tests designed to determine visual efficiency interrelated, measured the same thing, or evaluated various aspects of vision and/or perceptual responses of trainable mentally retarded children; and (4) the extent to which commercially available test instruments designed to determine visual acuity and muscle deviation and the extent to which modified/constructed tests designed to determine visual efficiency were in agreement with the clinical evaluations of an ophthalmologist. Two test batteries were employed. Those batteries were Series I, which consisted of eight commercially available instruments, and Series II, which consisted of ten modified/

constructed tests presented tachistoscopically within limits of exposure time of .01 second to 1.0 second, inclusively. Each test, where possible, was administered to each child on a pretest, training, posttest basis.

The laboratory in which each vision test was administered was carefully standardized for control of environment. The tachistoscopic environment also was held constant at all times. The procedure followed in administering each of the commercially available tests was in accordance with test instruction included in the manual or instruction sheet for each of the individual tests. Each of the modified/constructed tests was presented tachistoscopically with all response boards being presented in an environmental atmosphere which simulated that of the tachistoscope, i.e., physical and lighting conditions were identical to those of the tachistoscope.

The major results of this study are discussed in relation to the four phases outlined in the initial paragraph of this summary.

Performance of the trainable child on commercially available test instruments designed to determine visual acuity and muscle deviation.

1. The Sjogren, American Optical Kindergarten Test, and Keystone Preschool Test, tests of visual acuity included in Series I, commercially available tests, were significantly

correlated with the American Optical Illiterate E (Snellen Chart).

2. There was no significant difference between the Sjogren and American Optical Kindergarten Test of Series I, commercially available tests.
3. When the Sjogren and Keystone Preschool Test performances were considered for the group, the two tests were found to be significantly different.
4. Performance on the Massachusetts Vision Test, Tests 3, 4A, and 4B, and performance on the Allied Muscle Balance Test were equal, i.e., performances did not differ significantly.
5. Correlations were significant between the pretest and post-test performances on the American Optical Illiterate E, Sjogren, American Optical Kindergarten Test, and Keystone Preschool Test.
6. There was a difference between pretest and post-test performance for Tests 3, 4A, and 4B of the Massachusetts Vision Test which was the result of training and/or maturation.
7. There was no significant difference between pretest and post-test performance on the Allied Muscle Balance Test.

8. Performance scores on the Visual Achievement Forms indicated that the form perception of trainable mentally retarded children, in terms of copying ability, improved for the youngest group of children, mentally and chronologically, but did not differ significantly over time for older trainable retarded children.
9. Performance scores on the Dvorine Pseudo-Isochromatic Plates, Section 2, indicated a tendency to show a significant increase in color perception over time and with maturation.

Kinds of perceptual behavior which were observed when pictures, figures, silhouettes, or letters were presented tachistoscopically for varying lengths of time.

1. Each of the nine modified/constructed tests was significantly correlated with the Snellen E. Target-types for each of the modified/constructed tests are included in Appendix A.
2. With two exceptions, there was no significant difference between the timed-response scores of the Snellen E and the nine modified/constructed tests for the 20/20 target size. Those exceptions were: (a) significantly better timed-response score for the Sjogren Hand, fingers oriented up,

than on the Snellen E, arms oriented up, for the right eye, post-test; and (b) significantly better timed-response score for the Sjogren Hand, fingers oriented up, than on the Snellen E, arms oriented up, for the left eye, post-test.

3. With five exceptions, there was no significant difference between the timed-response scores of the Snellen E and the nine modified/constructed tests for the 20/30 target size. Those exceptions were: (a) significantly better timed-response score for the Sjogren Hand, fingers oriented left, than on the Snellen E, arms oriented left, for the pretest, right eye; (b) significantly better timed-response score for the Snellen E, arms oriented left, than on the Keystone glass for the right eye, pretest; (c) significantly better timed-response score for the Keystone glass than on the Snellen E, arms oriented left, for the left eye, post-test; (d) significantly better timed-response score for the duck, black line on white, of M/C 1 than on the Snellen E, arms oriented left, for the right eye, pretest; and (e) significantly better timed-response score for the duck, black silhouette on white, of M/C 2 than on the Snellen E, arms oriented left, for the left eye, post-test.

4. With three exceptions, there was no significant difference between the timed-response scores of the Snellen and the nine modified/constructed tests for the 20/50 target size. Those exceptions were: (a) significantly better timed-response score for the Sjogren Hand, fingers oriented right, than on the Snellen E, arms oriented right, for the left eye, pretest; (b) significantly better timed-response score for the E, arms oriented right, than on the Keystone Preschool cat, left eye, pretest; and (c) significantly better timed-response score for the E, arms oriented right, than for the Visual Achievement square, left eye, pretest.
5. With four exceptions, there was no significant difference between the timed-response scores of the Snellen E and the nine modified/constructed tests for the 20/70 target size. Those exceptions were: (a) significantly better timed-response score for the E, arms oriented down, than on the Sjogren Hand, fingers oriented down, for the right eye, pretest; (b) significantly better timed-response score for the E, arms oriented down, than on the circle of the Kindergarten Chart, right eye, post-test; (c) significantly better timed-response score for the E, arms oriented down, than on the cross of the Visual Achievement, left eye,

pretest; and (d) significantly better timed-response score for the E, arms oriented down, than on the fish, black silhouette on white, of the M/C 2, right eye, pretest.

6. With one exception, there was no significant difference between the timed-response scores of the Snellen E and the nine modified/constructed tests for the 20/200 target size. That one exception was a significantly better timed-response score for the bus, black line on white, of the M/C 1 than on the Snellen E, arms oriented up, for the right eye, pretest.
7. The pretest performance on nine of the ten modified/constructed tests of Series II was significantly correlated with post-test performance. Treatment of the data of the Kindergarten Chart with the Wilcoxon test indicated that there was no significant difference between pretest and post-test performance.

Findings of the extent to which commercially available tests of visual acuity and of muscle deviation and the extent to which modified/constructed tests designed to determine visual efficiency interrelated, measured the same thing, or evaluated various aspects of vision and/or perceptual responses of trainable mentally retarded children.

1. There was no significant difference between the two factors of visual acuity and perception for 77 of 98 sub-tests, 78%

of the response items, when the difference in performance between the four Series I and Series II tests which used the same visual targets was considered. Those tests were the Sjogren and Sjogren Hand, American Optical Kindergarten Test and Kindergarten Chart, American Optical Illiterate E and Snellen E, and the Keystone Preschool Test and Keystone Preschool.

2. For 21 of 98 sub-tests, 22% of the response items, the difference in performance between the four Series I and Series II tests which used the same visual targets could be attributed to training. Those tests were listed under number one above.
3. In no instance was the difference in performance between the four Series I and Series II tests which used the same visual targets attributed to a discrepancy in perception. Those tests were the Sjogren and Sjogren Hand, American Optical Kindergarten Test and Kindergarten Chart, American Optical Illiterate E and Snellen E, and the Keystone Preschool Test and Keystone Preschool.

Findings of the extent to which commercially available test instruments designed to determine visual acuity and muscle deviation and the extent to which modified/constructed tests designed to determine visual efficiency were in agreement with the clinical evaluations of an ophthalmologist.

1. The screening findings of the Sjogren, Series I, when compared with clinical judgment, yielded the highest number and percentage of correct referrals; however, screening findings of the American Optical Illiterate E and the American Optical Kindergarten Chart compared favorably with those of the Sjogren, Series I, and should be considered.
2. There seems to be a basis for including a test of the nature of the Plus Sphere Test, Test 2 of the Massachusetts Vision Test, in a battery used to screen for visual anomalies of trainable mentally retarded children.
3. Consideration of muscle deviations in retarded children is an important factor. Comparison of screening findings of Tests 3, 4A, and 4B of the Massachusetts Vision Test with clinical findings indicated that screening tests for muscle deviations could be included in a battery used to screen for visual anomalies of trainable mentally retarded children.
4. The screening findings of the Sjogren Hand, Series II, when compared with clinical judgment, yielded the highest number and percentage of correct referrals; however, screening findings of the Snellen E, M/C 1, M/C 3, and

M/C 5 compared favorably with those of the Sjogren Hand, Series II, and should be considered.

Recommendations

The results of this study indicated factors which have various implications. Those factors may be considered under two general headings: research and education.

Implications for research. This study, by its very nature, required the use of a small sample; however, the statistical treatment of data employed was designed specifically for a sample of twenty-five or less. The results yielded by the data of this study have shown trends. It is recommended strongly that a standardizing study be initiated. Such a study should use a large sample population and compare screening findings with clinical ophthalmological findings. A study of that scope would yield data from which a valid visual screening procedure for trainable retarded children could be constructed. Full consideration should be given the following trends indicated by this study:

1. The Sjogren, American Optical Kindergarten Test, and Keystone Preschool Test, each a test of visual acuity from Series I, were significantly correlated with the American Optical Illiterate E (Snellen Chart); however, the Sjogren correctly referred 9% more children than did either the

American Optical Illiterate E or the American Optical Kindergarten Chart.

2. It is recommended that the Keystone Preschool Test not be considered due to its design which requires use of a telebinocular instrument as well as screening only 20/70 and 20/40 levels of visual acuity.
3. Training resulted in no significant difference between pretest and post-test performances on the Sjogren, American Optical Illiterate E, and American Optical Kindergarten Test, each a test of visual acuity from Series I.
4. Training and/or maturation resulted in a significant difference between pretest and post-test performances on the tests for muscle deviations, Test 3, 4A, and 4B of the Massachusetts Vision Test.
5. The physical design of the Allied Muscle Balance Test requires eye-hand coordination which precludes its use with many trainable retarded children; therefore, its use with this category of exceptional children is questionable.
6. Each of the nine modified/constructed tests of Series II was significantly correlated with the tachistoscopically presented Snellen E. In each of the five target sizes, 20/200, 20/70, 20/50, 20/30, and 20/20, there were one, four,

three, five, and two exceptions, respectively, where there was a significant difference between the timed-response scores of the Snellen E and one or more of the nine modified/constructed tests. In choosing target-types for a standardizing study, consideration should be given to those findings.

Further trends were indicated by this study in the areas of color and form perception. Implications for additional research in those areas were:

1. Performance scores on the Dvorine Pseudo-Isochromatic Plates, Section 2, indicated a tendency to show a significant increase in color perception over time and with maturation.
2. There was a significant improvement in the form perception of chronologically and mentally young trainable retarded children; however, there was also no significant improvement in older trainable retarded children, i.e., results of this study seem to indicate that trainable retarded children reach an early plateau in form perception with no significant improvement over time and with maturation.
3. There seems to be a discrepancy between the findings concerning color perception and form perception of trainable retarded children. Does such a discrepancy exist or would a further investigation yield different results? On the basis

of the above noted findings, there seem to be implications for further research concerning color and form perception of trainable retarded children.

Implications for education. The results of this study indicate that certain screening techniques which currently are available commercially for use in screening school children of normal intelligence for visual defects yield results when used with trainable retarded children that compare favorably with clinical ophthalmological findings. Screening procedures which yield such results are the Sjogren, American Optical Kindergarten Test, American Optical Illiterate E, Plus Sphere Test, Test 2 of the Massachusetts Vision Test, and the Maddox Rod Tests, Tests 3, 4A, and 4B of the Massachusetts Vision Test. It should be noted that the basis for referral used in this study was the comparison of results from two screening tests on each instrument. The necessity for two screening evaluations cannot be over emphasized. In no instance should a trainable retarded child be referred for professional eye care on the basis of one screening evaluation on one instrument.

Information yielded by the sections of this study which investigated the color perception and the form perception of trainable children should help teachers of trainable children to establish baselines for improvement in those areas. Such information also should stimulate some basic action research from master teachers who actually are working daily with trainable children.

Dissemination of the results of this study through educational, ophthalmological, optometric, and public educational medias of communication should help to make those areas of the general population more aware that there presently are available techniques which are valid for use with trainable retarded children. A further result of the findings yielded by this study should be the stimulation of additional studies in the areas of visual acuity, perception, and muscle deviations which were included in this study.

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APPENDICES

APPENDIX A

APPENDIX A

Appendix A consists of test targets for Series II, ten modified and/or constructed tests presented tachistoscopically within limits of exposure 0.01 second to 1.0 second, inclusively. Each of the ten tests utilized target sizes of 20/200, 20/70, 20/50, 20/30, and 20/20. The five modified tests and targets used were:

1. Sjogren Hand. Targets consisted of the hand in up, down, right, and left orientations. Target was adapted from A New Series of Test Cards for Determining Visual Acuity in Children (Sjogren).

2. Kindergarten Chart. Targets consisted of boat, circle, cross, square, and heart. Each target was an adaptation from the American Optical Kindergarten Chart.

3. Snellen E. Targets used for the Snellen E consisted of the E in up, down, right, and left orientations. Target was adapted from the American Optical Illiterate E.

4. Visual Achievement. The circle, cross, square, triangle, and divided rectangle were used as targets. Targets were adapted from Lowder (71) and reproduced according to the Snellen formula.

5. Keystone Preschool. Targets used were the rooster, rabbit, cat, glass, and house. Targets were adapted from the Keystone Preschool Test.

The constructed tests were drawn from toys which were within the experiential background of the experimental population. There were five constructed tests, with each test consisting of five targets: bus, fish, boat, duck, and ball. The variation between those constructed tests consisted of the type of figure, outline or silhouette, background and target color, and context background. The constructed tests were presented in the following target types:

M/C 1. Black line drawing on white background.

M/C 2. Black silhouette on white background.

M/C 3. White line drawing on black background.

M/C 4. White silhouette on black background.

M/C 5. Black line drawing with target in context background; specifically: bus with buildings; fish with hook; boat in water; duck swimming in water; and ball with bat.

Visual targets were delarged so as to present the Snellen twenty-feet equivalent for the fifty-six centimeters focal length of the tachistoscope. The eye-piece of the tachistoscope was fitted with lenses which allowed the individual with an emmetropic eye to view the target from a distance equivalent to twenty feet.

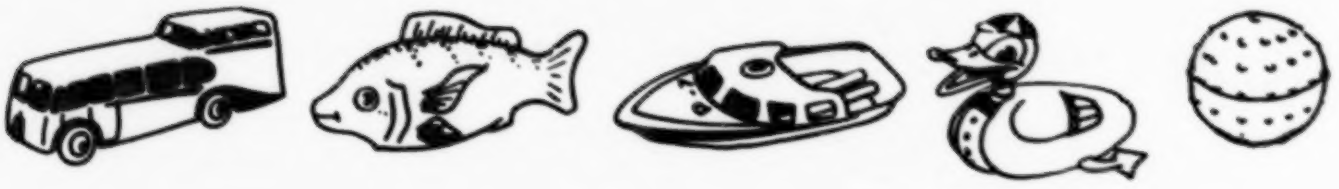
The visual targets included in this appendix were reproduced from film negatives of the 20/200 size, which measured 8.13 millimeters at its greatest length. In the enlarging process from that small size, there was some slight distortion of targets.

Actual tachistoscopic target size for each of the Snellen equivalents was as follows: 20/200, 8.13 millimeters; 20/70, 2.84 millimeters; 20/50, 2.11 millimeters; 20/30, 1.55 millimeters; and 20/20, 0.81 millimeter.

Two modified tests, Kindergarten Chart and Visual Achievement, each used the circle, cross, and square as targets; however, those targets were not used for the same Snellen-equivalent size. The circle was the 20/200 target for the Visual Achievement while it was employed as the 20/70 target for the Kindergarten Chart. The Visual Achievement used the cross for the 20/70 target and the Kindergarten Chart used it for the 20/50 target. The square was used as the 20/50 target size for the Visual Achievement and as the 20/30 target size for the Kindergarten Chart.

CONSTRUCTED TESTS

M/C 1

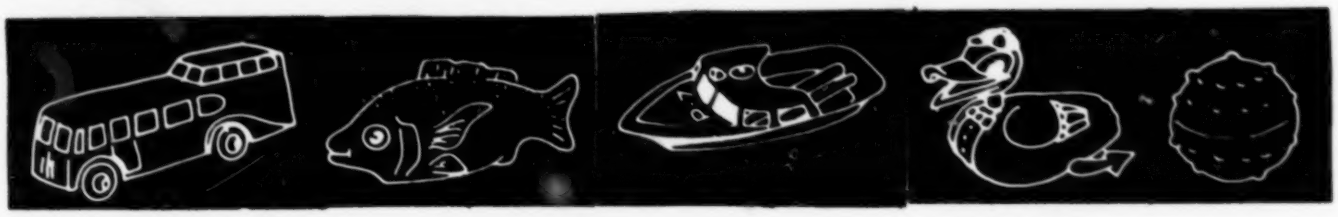


20/200 20/70 20/50 20/30 20/20

M/C 2

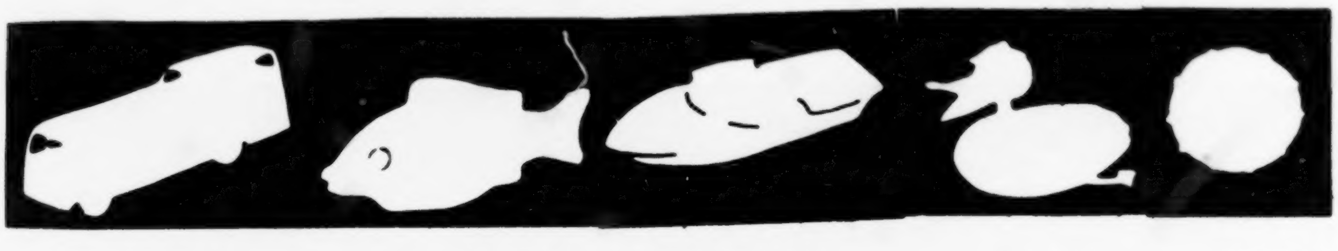
20/200 20/70 20/50 20/30 20/20

M/C 3



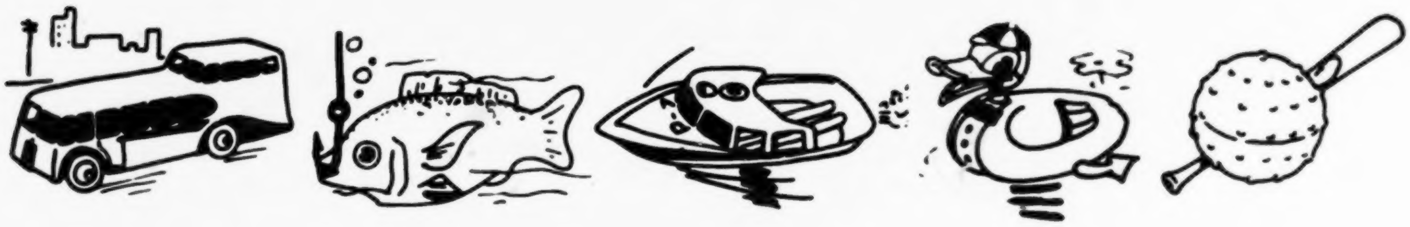
20/200 20/70 20/50 20/30 20/20

M/C 4



20/200 20/70 20/50 20/30 20/20

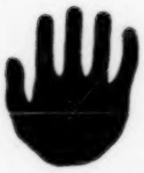
M/C 5



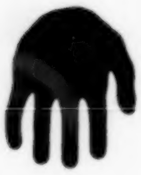
20/200 20/70 20/50 20/30 20/20

MODIFIED TESTS

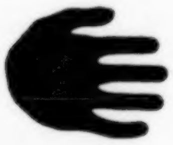
Sjogren Hand



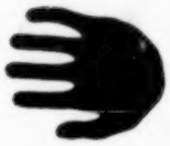
20/200 & 20/20



20/70

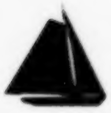


20/50

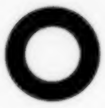


20/30

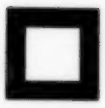
Kindergarten Chart



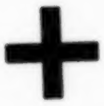
20/200



20/70



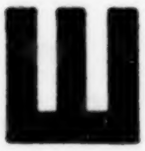
20/50



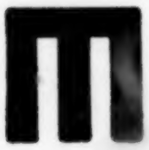
20/30

20/20

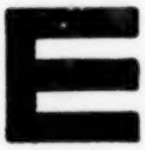
Snellen E



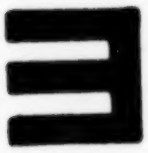
20/200 & 20/20



20/70

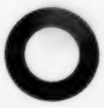


20/50

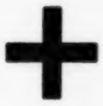


20/30

Visual Achievement

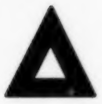


20/200



20/70

20/50



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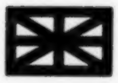
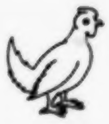
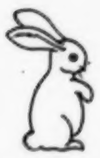


20/20

Keystone Preschool



20/200



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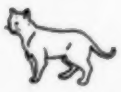

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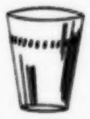

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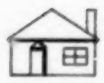

20/20

APPENDIX B

APPENDIX B

Appendix B consists of all positive findings concerning each child included in the study. Those data included consist of baseline medical, ophthalmological, otolaryngological, psychological, and diagnostic findings.

The psychological evaluation consisted of the Stanford-Binet Intelligence Scale, Form L; the Vineland Social Maturity Scale; observation and interpretation of free drawings; the examining psychologist's evaluation of sensory responses, speech ability, and coordination; and the psychologist's global evaluation of the child in the testing situation. Two such psychological evaluations were completed for each child, one in 1957 as the project began, and the second evaluation in May, 1959 as the project neared its completion.

The medical evaluation included a complete pediatric examination; a neurological evaluation which included an electroencephalogram; laboratory tests which included blood chemistry and urinalysis; and ophthalmological and otolaryngological evaluations. The ophthalmological evaluation included external examination; pupillary reactions, tension, ophthalmoscopic examination, muscle examination, and prescription of treatment or corrective lenses where indicated. Each of the above evaluations was completed for each child in 1957 as the project began. A second ophthalmological and otolaryngological evaluation was completed for each child in May, 1959. A height, weight, and head circumference measurement was completed for each child at the time of ophthalmological and otolaryngological evaluation in May, 1959.

A verbatim notation from anecdotal records of responses to visual screening situations on the tachistoscopic presentations of the modified/constructed tests of Series II is included. It was felt that those notations would help to give insight into the reactions of trainable children in such an experimental setting.

Case Number 1

Sex: Female

Ethnic Group: Anglo

Childhood Diseases:
Measles

Siblings: Three sisters

Marital Status of Parents
Married

Date of Birth: March 21, 1952

Prenatal and Natal History: Mongoloid and precipitant delivery

Mother's Health History:
Negative

Educational Level of Father:
Grades 7-12

Educational Level of Mother:
Grades 7-12

Psychological Evaluation: Two evaluations, July, 1957 and May, 1959

	July, 1957	May, 1959
Chronological Age:	5-4	7-1
Mental Age:	1-8	2-11
Social Age:	4-7	7-4
Verbal Age:	1-6	2-10
Performance Age:	1-10	3-0
Intelligence Quotient:	31	41
Social Quotient:	86	104
Verbal Quotient:	28	40

Electroencephalography:

EEG Waking: Minimal

EEG Sleeping: Minimal

Diagnosis: Mongoloid, neurologically normal

Ear, Nose, and Throat Examination: Two examinations, September, 1957 and May, 1959

Right drumhead abnormal, 9/57; abnormal, retracted, 5/59

Left drumhead, abnormal, retracted, 5/59

Nose, moderate crusting, 9/57; watery discharge, 5/59

Ophthalmological Examination: Two examinations, September, 1957 and May, 1959

Eyelids very red, subacute blepharitis, 9/57; aubacute blepharitis, 5/59

Diagnosis, 9/57, right eye, hyperopic (mild) astigmatism (moderate), left eye, hyperopic (mild) astigmatism (moderate), glasses recommended

Diagnosis, 5/59, right eye, emmetropia, left eye, hyperopic (mild) astigmatism (mild), glasses not recommended

Medical Examination:

Head Shape: Brachycephalic

Heart: Probable congenital heart lesion

Height, Weight, Head Circumference, as compared with norms for American children from Watson and Lowrey (80):

	September, 1957	May, 1959
Percentile comparison, Height	10th percentile	Below 10th percentile

Percentile comparison, Weight	Below 10th percentile	Below 10th percentile
Weight Deviation for Age and Sex	-2 sigma to -1 sigma	-2 sigma to -1 sigma
Height Deviation for Age and Sex	-2 sigma to -1 sigma	Greater than -3 sigma
Head Circumference	-1.5 sigma to -2 sigma	Greater than -3 sigma

Response to Visual screening situations, as noted verbatim from anecdotal records of test record sheets:

Series II, Pretest: "Peep-eye, peek-a-boo!" Responded as to a funny situation. Outgoing, free from all tension.

Case Number 2

Sex: Female

Ethnic Group: Anglo

Childhood Diseases: Measles, chicken pox

Siblings: Negative

Marital Status of Parents: Married

Date of Birth: April 13, 1950

Prenatal and Natal History: Mongoloid, prolonged labor, cyanosis

Mother's Health History: Severe illness during pregnancy

Educational Level of Father: Grades 7-12

Educational Level of Mother: Grades 7-12

Psychological Evaluation: Two evaluations, June, 1957 and May, 1959

	June, 1957	May, 1959
Chronological Age:	7-2	9-1
Mental Age:	3-4	3-10
Social Age:	3-4	4-6
Verbal Age:	3-3.5	3-10
Performance Age:	3-6	3-10
Intelligence Quotient:	47	42
Social Quotient:	47	50
Verbal Quotient:	46	42

Electroencephalography:

EEG Waking: Minimal

EEG Sleeping: Minimal, 2/sec. spike, movement artifacts

Diagnosis: Mongoloid, neurologically abnormal, moderate

Ear, Nose, and Throat Examination: Two examinations, September, 1957 and May, 1959

Right drumhead, abnormal, retracted, 9/57; abnormal, edematous, 5/59

Left drumhead, abnormal, retracted, poor light reflex, 9/57; abnormal, edematous, 5/59

Nose, watery discharge, 9/57; watery discharge, 5/59

Tonsils very hypertrophied, removal recommended, 9/57; tonsils very hypertrophied, 5/59

Opthalmological Examination: Two examinations, September, 1957 and May, 1959

Chronic blepharitis, 9/57; chronic blepharitis, 5/59

Eye Muscles, positive, alternating esophoria, right eye, poor muscle control, 9/57; positive, esophoria, right eye, 5/59

Diagnosis, 9/57, right eye, compound hyperopic (mild, mild) astigmatism (severe), left eye, compound hyperopic (mild, mild) astigmatism (severe), glasses recommended

Diagnosis, 5/59, right eye, compound hyeropic (mild, mild) astigmatism (moderate), left eye, compound hyperopic (mild, mild) astigmatism (moderate), glasses worn

Medical Examination:

Head Shape: Brachycephalic

Heart: Probable congenital heart lesion

Height, Weight, Head Circumference as compared with norms for American Children as presented by Watson and Lowrey (80):

	September, 1957	May, 1959
Percentile comparison, Height	Below 10th percentile	Below 10th percentile
Percentile comparison, Weight	Below 10th percentile	Below 10th percentile
Weight Deviation for Age and Sex	-1.5 sigma to -2 sigma	-1.5 sigma to -2 sigma
Height Deviation for Age and Sex	Greater than -3 sigma	Greater than -3 sigma
Head Circumference	-1.5 sigma to -2 sigma	-1.5 sigma to -2 sigma

Response to visual screening situations, as noted verbatim from anecdotal records of test sheets:

Tachistoscope, Series II, Pretest: "Keep it going, come on 'Saspur.'" When not "seeing," very random selection on response board. Tending to perseverate on one position on response board on AO Kg. . . . . , ______ is stubborn, when she doesn't get her way, she looks but "just can't see."

Visual Acuity .. some position perseveration. ______ has been here some 12 times.

Tachistoscope, Series II, Post-test: ______'s standard procedure is to want to "go po-po" as soon as she gets to the T-scope.

Case Number 3

Sex: Female

Ethnic Group: Anglo

Childhood Diseases: Chicken pox, history of convulsions

Siblings: One sister

Marital Status of Parents: Married

Date of Birth: August 1, 1947

Prenatal and Natal History: Precipitant delivery with use of forceps

Mother's Health History: Negative

Educational Level of Father: Grades 7-12

Educational Level of Mother: Grades 7-12

Psychological Evaluation: Two evaluations, July, 1957 and May, 1959

	July, 1957	May, 1959
Chronological Age:	9-11	11-9
Mental Age:	2-5	2-5
Social Age:	3-4	3-10
Verbal Age:	2-6	2-6
Performance Age:	2-4	2-4
Intelligence Quotient:	24	21
Social Quotient	34	33
Verbal Quotient:	25	21

Electroencephalography:

EEG Waking: Moderate

EEG Sleeping: Moderate, unilateral focus abnormality, left; 3/sec. spike, asymmetry, movement artifacts.

Diagnosis: Non-mongoloid with neurologic defect, moderate

Ear, Nose, and Throat Examination: Two examinations, September, 1957 and May, 1959

Right drumhead abnormal, poor light reflex, 5/59

Nose, positive, watery discharge, 5/59

Tonsils, hypertrophied, enlarged, 9/57; tonsils, hypertrophied, enlarged, 5/59

Ophthalmological Examination: Two examinations, September, 1957 and May, 1959

Optic nerves very white, right eye and left eye, 9/57; optic nerves very white, right eye and left eye, 5/59

Right eye muscles, positive, exotropia, nystagmus, 9/57; right eye muscles, positive, exotropia, nystagmus, inferior oblique paralyzed, 5/59

Left eye muscles, positive, exotropia, nystagmus, inferior oblique paralyzed, 9/57; left eye muscles, positive, exotropia, mystagmus, inferior oblique paralyzed, 5/59

Diagnosis, 9/57, right eye, mixed (mild, moderate) astigmatism (severe), left eye, mixed (mild, severe) astigmatism (severe), glasses worn.

Diagnosis, 5/59, right eye, myopic (moderate) astigmatism (mild), left eye, compound myopic (mild, severe) astigmatism (severe), glasses worn.

Medical Examination:

Heart: Probable congenital heart lesion. Buffalo type obesity.

Height, Weight, Head Circumference as compared with norms for American children as presented by Watson and Lowrey (80):

	September, 1957	May, 1959
Percentile comparison, Height	Below 90th percentile	Above 10th percentile
Percentile comparison, Weight	Below 10th percentile	Above 50th percentile
Weight Deviation for Age and Sex	Mean to plus 1 sigma	-1 sigma to mean
Height Deviation for Age and Sex	-2 sigma to -1 sigma	-1 sigma to mean
Head Circumference	Greater than -3 sigma	Greater than -3 sigma

Response to visual screening situations, as noted verbatim from anecdotal records on test record sheets:

Tachistoscope, Series II, Pretest: AO Kg.: "That's airplane." Sjogren: "Pretty bird." Always saw a bird. "There's a light!" "It's red!" When light was on. . . . showed no recognition.

Tachistoscope, Series II, Post-test: Only child that has been able to count "blasts," "One, two, three," as light flashed within T-scope.

Case Number 4

Sex: Female

Date of Birth: September 19, 1945

Ethnic Group: Latin

Prenatal and Natal History: Premature

Childhood Diseases: Whooping cough and chicken pox

Mother's Health History: Negative

Siblings: Three brothers and three sisters

Educational Level of Father: Grades 7-12

Marital Status of Parents: Married

Educational Level of Mother: Grades 7-12

Psychological Evaluation: Two evaluations, September, 1957 and May, 1959

	September, 1957	May, 1959
Chronological Age:	12-0	13-8
Mental Age:	2-9	3-0
Social Age:	3-10	4-6
Verbal Age:	3-0	2-5.5
Performance Age:	3-1.5	3-7
Intelligence Quotient:	25	22
Social Quotient:	30	33
Verbal Quotient:	25	18

Electroencephalography:

EEG Waking: Normal, slow wave, fast wave

EEG Sleeping: Not taken

Notation that record quality was unsatisfactory, movement artifacts

Diagnosis: Non-mongoloid with neurologic defect, moderate

Ear, Nose, and Throat Examination: Two examinations, September, 1957 and May, 1959

Right drumhead abnormal, opaque, 9/57; abnormal, opaque, 5/59

Left drumhead abnormal, poor light reflex, 9/57; abnormal, opaque, 5/59

Nose, positive, 9/57; positive, watery discharge, 5/59

Tonsils, hypertrophied, enlarged, 9/57; hypertrophied, enlarged, 5/59

Ophthalmological Examination: Two examinations, September, 1957 and May, 1959

Diagnosis, 9/57, Hyperopic (mild) astigmatism (mild), bilateral

Diagnosis, 5/59, Hyperopic (mild) astigmatism (mild), bilateral

Medical Examination:

Height, Weight, Head Circumference as compared with norms for American children as presented by Watson and Lowrey (80):

	September, 1957	May, 1959
Percentile comparison, Height	Above 10th percentile	50th percentile

Percentile comparison, Weight	Below 50th percentile	Below 50th percentile
Weight Deviation for Age and Sex	-2 sigma to -1 sigma	-1 sigma to mean
Height Deviation for Age and Sex	-2 sigma to -1 sigma	-1 sigma to mean
Head Circumference	-1 sigma to mean	-2 sigma to -1 sigma

Response to visual screening situations, as noted verbatim from anecdotal records on test record sheets:

Tachistoscope, Series II, Pretest: Very quiet, anxious to please.

Tachistoscope, Series II, Post-test: Down E unable to do for some reason -- orientation? Right training card, M/C 1, linear in response. Sjogren responses uncertain.

Case Number 5

Sex: Male

Ethnic Group: Anglo

Childhood Diseases: Measles and mumps

Siblings: One sister

Marital Status of Parents: Married

Date of Birth: September 25, 1949

Prenatal and Natal History: Negative

Mother's Health History: Severe illness during pregnancy

Educational Level of Father: Bachelor of Arts

Educational Level of Mother: Junior College

Psychological Evaluation: Two evaluations, September, 1957 and May, 1959

	September, 1957	May, 1959
Chronological Age:	8-0	9-7
Mental Age:	2-6	3-0
Social Age:	2-10	5-7
Verbal Age:	2-0	3-0
Performance Age:	3-0	3-0
Intelligence Quotient:	31	31
Social Quotient:	35	58
Verbal Quotient:	25	31

Electroencephalography:

EEG Waking: Normal

EEG Sleeping: Normal, slow wave

Diagnosis: Non-mongoloid with neurologic defeat, moderate

Ear, Nose, and Throat Examination: Two examinations, September, 1957 and May, 1959

Left drum abnormal, nose positive, 9/57; right ear drum abnormal, appearance subsiding otitis media, left ear drum abnormal, appearance of subsiding otitis media, mucus in middle ear, evidence of middle ear disease, right and left ears, 5/59

Tonsils, hypertrophied, enlarged

Nose, positive, watery discharge, 5/59

Opthalmological Examination: Two examinations, September, 1957 and May, 1959

Diagnosis, 9/57, Hyperopic (mild) astigmatism (mild), bilateral

Diagnosis, 5/59, Hyperopic (mild) astigmatism (mild), bilateral

Left eye muscles, positive, esophonia; poor muscle control, 5/59

Heart: Probable congenital heart lesion

Medical Examination:

Height, Weight, Head Circumference, as compared with norms for American children from Watson and Lowrey (80);

	September, 1957	May, 1959
Percentile comparison, Height	Below 10th percentile	Below 10th percentile

Percentile comparison, Weight	Below 10th percentile	Below 10th percentile
Weight Deviation for Age and Sex	-1.5 sigma to -2 sigma	-2 sigma to -1 sigma
Height Deviation for Age and Sex	-1.5 sigma to -2 sigma	-1.5 sigma to -2 sigma
Head Circumference	-1 sigma to mean	mean to plus 1 sigma

Response to visual screening situations, as noted verbatim from anecdotal records on test record sheets:

Tachistoscope, Series II, Pretest: _____ needs firmness. This child gives impression of being severely disturbed. Plots his movements. Mother ill with lukemia. Difficult to co-operate. B---- took Jack's place and he worked on M/C 2. Had to be placed in chair; called for "Mommy!" "I want Mommy."

February 18, wanted, even begged to come. B---- puts his head in headpiece and says, "That's a good boy," and he performs.

February 25, I feel that _____ can do.

Tachistoscope, Series II, Post-test: M/C 3, 30 line, refused to look. Mother ill again.

Mother "bad" again. . . . _____ erratic. Position perseveration on Keystone.

Note: M/C 4, pass, June 10, also 20/50 pass, June 10.

Case Number 6

Sex: Female

Ethnic Group: Latin

Childhood Diseases: Measles, scarlet fever, chicken pox

Siblings: Two brothers and two sisters

Marital Status of Parents: Married

Date of Birth: November 19, 1948

Prenatal and Natal History: Mongoloid, premature, not normal length

Mother's Health History: Negative

Educational Level of Father: Grades 1-6

Educational Level of Mother: Grades 7-12

Psychological Evaluation: Two evaluations, July, 1957 and May, 1959

	July, 1957	May, 1959
Chronological Age:	8-8	10-6
Mental Age:	3-0	3-5
Social Age:	3-0	4-1
Verbal Age:	3-0	3-5
Performance Age:	3-0	3-4
Intelligence Quotient:	35	33
Social Quotient:	35	39
Verbal Quotient:	35	33

Electroencephalography:

EEG Waking: Moderate

EEG Sleeping: Moderate, unilateral focus abnormality, night Tracings spike, asymmetry

Diagnosis: Mongoloid, neurologically normal

Ear, Nose, and Throat Examination: Two examinations, September, 1957 and May, 1959

Nose, positive, considerable mucous, mucosa congested, 9/57

Nose, positive, considerable discharge present

Right ear drum abnormal, thickened; left ear drum abnormal, thickened, 5/59

Ophthalmological Examination: Two examinations, September, 1957 and May, 1959

Eyelids are very red, chronic blephanitis; ophthalmoscopic positive, 9/57

Subacute blepharitis, 5/59

Diagnosis, 9/59, right eye, hyperopic (mild) astigmatism (moderate); left eye, hyperopic (mild) astigmatism (moderate). Glasses recommended. Hyperopic astigmatism, bilateral

Diagnosis, 5/59, right eye, hyperopic (mild) astigmatism (moderate); left eye, hyperopic (mild) astigmatism (moderate). Glasses worn. Hyperopic astigmatism, bilateral

Medical Examination:

Head Shape: Brachycephalic

Hypertrichosis

Height, Weight, Head Circumference, as compared with norms for American children from Watson and Lowrey (80):

	September, 1957	May, 1959
Percentile comparison, Height	Below 10th percentile	Above 10th percentile
Percentile comparison, Weight	Above 50th percentile	Above 10th percentile
Weight Deviation for Age and Sex	-1 sigma to mean	-1 sigma to mean
Height Deviation for Age and Sex		
Head Circumference	-2 sigma to -1 sigma	-1.5 sigma to -2 sigma

Response to visual screening situations, as noted verbatim from anecdotal records of test record sheets:

Tachistoscope, Series II, Pretest: M/C 2 Fish/Boat confusion. Quite consistent in responses.

Certain in responses, goes linear when not certain. Children seem to give more weight to Visual Acuity's Divided Rectangle.

Tachistoscope, Series II, Post-test: Visual Achievement, will not point to formboard, oral responses (5/1/59). On left-right-up-down orientations, tends to linearity. . . response boards must be changed. _____ wants to verbalize answer instead of pointing. Handicap when lacking verbal symbol. Test without glasses even though _____ has been fitted.*

---

*Tested without glasses as glasses fitted after Series II, Pretest completed.

Case Number 7

Sex: Male

Ethnic Group: Anglo

Childhood Diseases:

Measles, convulsions

Siblings: One sister

Marital Status of Parents:

Married

Date of Birth: April 10, 1951

Prenatal and Natal History:

Forceps delivery

Incubated. Rh negative

Mother's Health History: Negative

Educational Level of Father:

Grades 7-12

Educational Level of Mother:

Grades 7-12

Psychological Evaluation: Two evaluations, June, 1957 and May, 1959

	June, 1957	May, 1959
Chronological Age:	6-2	8-1
Mental Age:	?	2-4 ?
Social Age:	2-7	4-2
Verbal Age:	?	2-2
Performance Age:	?	2-6
Intelligence Quotient:	?	29
Social Quotient:	42	52
Verbal Quotient:	?	27

Electroencephalography:

EEG Waking: Minimal

EEG Sleeping: Minimal, unilateral focus, abnormal, right

Tracings spike, slow wave

Diagnosis: Non-mongoloid with neurologic defect, moderate

Ear, Nose, and Throat Examination: Two examinations, September, 1957 and May, 1959

Nose, positive, septum thickened anteriorly, allergic rhinitis, 9/57

Right ear drum, abnormal, retracted, poor light reflex; left ear drum, abnormal, retracted, poor light reflex, 9/57 and 5/59. Nose, positive, septum thickened anteriorly, allergic rhinitis, considerable discharge present, 5/59

Ophthalmological Examination: Two examinations, September, 1957 and May, 1959

Diagnosis, 9/57, right eye, hyperopic (mild) astigmatism (severe), left eye, hyperopic (mild) astigmatism (moderate). Glasses recommended. Hyperopic astigmatism, bilateral

Diagnosis, 5/59, right eye, hyperopic (mild) astigmatism (mild), left eye, hyperopic (mild) astigmatism (mild). Glasses worn. Hyperopic astigmatism, bilateral

Medical Examination:

Bony abnormality of head

Height, Weight, Head Circumference, as compared with norms for American children from Watson and Lowrey (80):

	September, 1957	May, 1959
Percentile comparison, Height	Below 50th percentile	Below 50th percentile

Percentile comparison, Weight	Below 10th percentile	Below 10th percentile
Weight Deviation for Age and Sex	-2 sigma to -1 sigma	-2 sigma to -1 sigma
Height Deviation for Age and Sex	-1 sigma to mean	-2 sigma to -1 sigma
Head Circumference	Mean to +1 sigma	-1 sigma to mean

Response to visual screening situations, as noted verbatim from anecdotal records of test record sheets:

Tachistoscope, Series II, Pretest: AO Kg 20/200 and 20/70 "fast," 20/50 much slower, with randomness, _____ did not want to look at response board.

November 20, wanted to participate, but unable to do so. Visibly nervous and tense. Most difficult of all experimental group children to work with, a maximum of 3 to 4 responses per sitting.

February 6, came into school room while I was there, didn't take off coat, wanted to come. _____ seems to want to cooperate but just cannot in some situations. He then appears sorry and will try again.

Tachistoscope, Series II, Post-test: Most cooperative ever.

Case Number 8

Sex: Female

Ethnic Group: Anglo

Childhood Diseases:

Chicken pox

Siblings: None

Marital Status of Parents:

Married

Date of Birth: September 13, 1947

Prenatal and Natal History: Mongoloid, cyanatic, incubated

Mother's Health History: Negative

Educational Level of Father:

Grades 7-12

Educational Level of Mother:

Grades 7-12

Psychological Evaluation: Two evaluations, July, 1957 and May, 1959

	July, 1957	May, 1959
Chronological Age:	9-10	11-8
Mental Age:	2-3	2-7
Social Age:	3-2	3-11
Verbal Age:	2-4	2-6
Performance Age:	2-2	2-8
Intelligence Quotient:	23	22
Social Quotient:	32	34
Verbal Quotient:	24	21

Electroencephalography:

EEG Waking: Minimal

EEG Sleeping: Minimal, unlitareal focus abnormal, right

Diagnosis: Mongoloid, neurologically normal

Ear, Nose, and Throat Examination: Two examinations, September, 1957 and May, 1959

Nose, positive, watery discharge; shortened urula; tonsils very hypertrophied; T and A recommended, 9/57. Right ear drum abnormal, very retracted, poor light reflex, opaque; left drum very retracted, opaque; left ear drum, abnormal, very retracted, opaque, 5/59. Nose, positive, watery discharge; tonsils very hypertrophied, 5/59

Ophthalmological Examination: Two examinations, September, 1957 and May, 1959

Retina is very thin, 9/57

Diagnosis, 9/57, compound myopic (severe, mild) astigmatism (severe), right eye; compound myopic (moderate, mild) astigmatism (severe); glasses recommended. Diagnosis, 5/59, myopic (severe) astigmatism (severe), right eye; compound myopic (severe, moderate) astigmatism (severe); glasses worn

Medical Examination: Probable congenital heart lesion. Brachycephalic head shape. Blood count, anemic

Height, Weight, Head Circumference, as compared with norms for American children from Watson and Lowrey (80):

	September, 1957	May, 1959
Percentile comparison, Height	Below 10th percentile	Below 10th percentile

Percentile comparison, Weight	Below 10th percentile	Above 10th percentile
Weight Deviation for Age and Sex	-1.5 sigma to -2 sigma	-1.5 sigma to -2 sigma
Height Deviation for Age and Sex	-3 sigma	Greater than -3 sigma
Head Circumference	Greater than -3 sigma	-2 sigma to -1 sigma

Response to visual screening situations, as noted verbatim from anecdotal records of test record sheets:

Tachistoscope, Series II, Pretest: Difficult to get to look before touching response board. Said, "Come on," while waiting for a flash. Square/circle confusion rather consistently.

Case Number 9

Sex: Female

Ethnic Group: Anglo

Childhood Diseases: Measles and scarlet fever, history of convulsions

Siblings: One brother and one sister

Marital Status of Parents: Married

Date of Birth: September 3, 1948

Prenatal and Natal History: Induced labor, precipitant delivery, cyanosis

Mother's Health History: Negative

Educational Level of Father: Grades 7-12

Educational Level of Mother: Grades 7-12

Psychological Evaluation: Two evaluations, October, 1957 and May, 1959

	October, 1957	May, 1959
Chronological Age:	9-1	10-8
Mental Age:	2-7	3-1
Social Age:	3-10	4-4
Verbal Age:	2-6	2-11
Performance Age:	2-8	3-2
Intelligence Quotient:	28	29
Social Quotient:	42	41
Verbal Quotient:	28	27

Electroencephalography:

EEG Waking: Moderate

EEG Sleeping: Moderate, unilateral, focus abnormality, right

Tracings spike, asymmetry, movement artifacts

Diagnosis: Non-mongoloid with neurologic defect, severe

Ear, Nose, and Throat Examination: Two examinations, September, 1957 and May, 1959

Right ear drum, abnormal, moderately retracted, opaque; left ear drum, abnormal, moderately retracted, poor light reflex opaque, 9/57

Ophthalmological Examination: Two examinations, September, 1957 and May, 1959

Diagnosis, 9/57, hyperopic (mild) astigmatism (mild) right eye; hyperopic (mild) astigmatism (moderate), left eye

Diagnosis, 5/59, hyperopic (mild) astigmatism (mild), right eye; hyperopic (mild) astigmatism (moderate), left eye

Medical Examination: Blood count, anemic

Hemoglobin, anemic

Height, Weight, Head Circumference, as compared with norms for American children from Watson and Lowrey (80):

	September, 1957	May, 1959
Percentile comparison, Height	Below 50th percentile	Below 50th percentile
Percentile comparison, Weight	Below 10th percentile	Below 10th percentile

Weight Deviation for Age and Sex	-2 sigma to -1 sigma	-1.5 sigma to -2 sigma
Height Deviation for Age and Sex	-1 sigma to mean	-2 sigma to -1 sigma
Head Circumference	-2 sigma to -1 sigma	-2 sigma to -1 sigma

Response to visual screening situations, as noted verbatim from anecdotal records of test record sheets:

Tachistoscope, Series II, Pretest: Counts, 1, 2, 3, for flashes. Visual Achievement, circle/square confusion, consistent.

Hyperactive, disturbed. Often seems to have lost all contact with reality.

Tachistoscope, Series II, Post-test: M/C's 1, 2, 6, and E, and Kg done after at home with mother for three weeks. Mother and father are in proceedings for divorce. ERRATIC, April 22 . . . takes constant prodding.

May 8, stable as ever seen. Probably, with Case No. 7, the most difficult children in population.

Case Number 10

Sex: Female

Ethnic Group: Anglo

Childhood Diseases: Measles, chicken pox, convulsions

Siblings: One brother and one sister

Marital Status of Parents: Married

Date of Birth: May 13, 1949

Prenatal and Natal History: Incubated

Mother's Health History: Severe illness during pregnancy

Educational Level of Father: Grades 7-12

Educational Level of Mother: Grades 7-12

Psychological Evaluation: Two evaluations, October, 1957 and May, 1959

	October, 1957	May, 1959
Chronological Age:	8-5	10-0
Mental Age:	2-6	2-10
Social Age:	4-4	4-10
Verbal Age:	2-3.5	2-9
Performance Age:	2-8	2-11
Intelligence Quotient:	30	28
Social Quotient:	51	49
Verbal Quotient:	27	28

Electroencephalography:

EEG Waking: Normal

EEG Sleeping: Normal, slow wave

Diagnosis: Non-mongoloid with neurologic defect, moderate

Ear, Nose, and Throat Examination: Two examinations, September, 1957 and May, 1959

Left drum, abnormal, poor light reflex, 9/57. Nose, positive, rhinitis, acute, 9/57

Negative, 5/59

Ophthalmogical Examination: Two examinations, September, 1957 and May, 1959

Diagnosis, 9/57, hyperopic (mild) astigmatism (mild), right eye; hyperopic (mild) astigmatism (mild) left eye. Right eye muscles positive, congenital nystagmus; left eye muscles, positive, esotropia, congenital nystagmus. Glasses worn

Diagnosis, 5/59, hyperopic (mild) astigmatism (mild), right eye; hyperopic (mild) astigmatism (mild), left eye. Right eye muscles, positive, congenital nystagmus. Left eye muscles, positive, exotropia, congenital nystagmus

Medical Examination: Negative

Height, Weight, Head Circumference, as compared with norms for American children from Watson and Lowrey (80):

	September, 1957	May, 1959
Percentile comparison, Height	Below 10th percentile	Below 10th percentile

Percentile comparison, Weight	Below 10th percentile	Above 10th percentile
Weight Deviation for Age and Sex	-2 sigma to -1 sigma	-2 sigma to -1 sigma
Height Deviation for Age and Sex	Greater than -3 sigma	-2 sigma to -1 sigma
Head Circumference		Greater than -3 sigma

Response to visual screening situations, as noted verbatim from anecdotal records of test record sheets:

Tachistoscope, Series II, Pretest: "OK, 'top now," after one flash at AO Kg, number one. "OK, 'top now," after third one number three and was quite consistent on three blasts.

Reversals on Sjogren. "Come on." "I said come on!" _____'s responses are amazingly certain when she gets "on target."

Does not stay on one response so as to say perseveration, not too patterned. Reversals on E's.

Tachistoscope, Series II, Post-test: Tells "I don't know" when not sure on M/C 4. AO Kg and Sjogren done after school was out three weeks, seemed slower on response. (First time, no glasses, had lost, unable to see, April 20.)

Case Number 11

Sex: Female

Ethnic Group: Anglo

Childhood Diseases: Convulsions, measles, chicken pox

Siblings: Three brothers and one sister

Marital Status of Parents: Married

Date of Birth: June 9, 1945

Prenatal and Natal History: Mongoloid, breech

Mother's Health History: Negative

Educational Level of Father: Grades 7-12

Educational Level of Mother: Grades 7-12

Psychological Evaluation: Two evaluations, September, 1957 and May, 1959

	September, 1957	May, 1959
Chronological Age:	12-3	13-11
Mental Age:	3-0	3-5
Social Age:	6-1	6-10
Verbal Age:	2-11.5	3-3
Performance Age:	3-0	3-8
Intelligence Quotient:	24	25
Social Quotient:	50	50
Verbal Quotient:	24	23

Electroencephalography:

EEG Waking: Normal

EEG Sleeping: Normal, slow wave

Diagnosis: Mongoloid, neurologically normal

Ear, Nose, and Throat Examination: Two examinations, September, 1957 and May, 1959

Right drum abnormal, subsiding otitis media; left drum, abnormal, poor light reflex, edematous, 9/57. Nose, positive, mucopus present; tonsils very hypertrophied, 9/57. Nose, positive, moderate crusting; tonsils, hypertrophied enlarged, 5/59. Right ear drum, abnormal, retracted; left ear drum, abnormal, retracted, 5/59

Ophthalmological Examination: Two examinations, September, 1957 and May, 1959

Diagnosis, 9/57, mixed (mild, mild) astigmatism (mild), right eye; mixed (mild, mild) astigmatism (moderate), left eye. Glasses recommended

Diagnosis, 5/59, myopic (mild) astigmatism (mild) right eye; myopic (mild) astigmatism (mild), left eye. Glasses recommended

Medical Examination: Brachycephalic head shape. Blood, anemic; hemoglobin, anemic

Height, Weight, Head Circumference, as compared with norms for American children from Watson and Lowrey (80):

	September, 1957	May, 1959
Percentile comparison, Height	Above 10th percentile	Below 10th percentile
Percentile comparison, Weight	Above 10th percentile	Above 10th percentile
Weight Deviation for Age and Sex	-2 sigma to -1 sigma	-2 sigma to -1 sigma
Height Deviation for Age and Sex	-1 sigma to mean	-1.5 sigma to -2 sigma
Head Circumference	-2 sigma to -1 sigma	-2 sigma to -1 sigma

Response to visual screening situations, as noted verbatim from anecdotal records of test record sheets:

Tachistoscope, Series II, Pretest: Tongue out, no response, EXTREME lethargy, always "I'm hungry," or "I'm tired." Passive, Passive. This S seems to have NO concept of target. Unable to associate target with response.

Case Number 13

Sex: Male

Date of Birth: July 11, 1949

Ethnic Group: Anglo

Prenatal and Natal History: Mongoloid, precipitant delivery

Childhood Diseases: None

Mother's Health History: Negative

Siblings: One brother and two sisters

Educational Level of Father: Grades 7-11

Marital Status of Parents: Married

Educational Level of Mother: Grades 7-11

Psychological Evaluation: Two evaluations, June, 1957 and May, 1959

	June, 1957	May, 1959
Chronological Age:	7-11	9-10
Mental Age:	2-2	3-5
Social Age:	3-0	4-6
Verbal Age:	1-8	3-0
Performance Age:	2-8	3-7
Intelligence Quotient:	27	35
Social Quotient:	38	46
Verbal Quotient:	21	31

Electroencephalography:

EEG Waking: Moderate

EEG Sleeping: Not taken

Diagnosis: Mongoloid, neurologically abnormal, mild

Ear, Nose, and Throat Examination: Two examinations, September, 1957 and May, 1959

Nose, positive, considerable discharge present; tonsils very hypertrophied, 9/57. Tonsils very hypertrophied, 5/59

Nose, positive, watery discharge, 5/59

Ophthalmological Examination: Two examinations, September, 1957 and May, 1959

Ulcerative Blepharitis, 9/57, 5/59

Diagnosis 9/57 and 5/59, hyperopic (mild) astigmatism (mild), bilateral

Medical Examination: Blood count, anemic

Height, Weight, Head Circumference, as compared with norms for American children from Watson and Lowrey (80):

	September, 1957	May, 1959
Percentile comparison, Height	Below 10th percentile	Below 10th percentile
Percentile comparison, Weight	Below 10th percentile	Below 10th percentile
Weight Deviation for Age and Sex	-2 sigma to -1 sigma	-2 sigma to -1 sigma
Height Deviation for Age and Sex	-2 sigma to -1 sigma	-2 sigma to -1 sigma
Head Circumference	-2 sigma to -1 sigma	-1.5 sigma to -2 sigma

Response to visual screening situations, as noted verbatim from anecdotal records of test record sheets:

Tachistoscope, Series II, Pretest: Tendency to go around response board in sequence.

Tendency to linear response until "on target" when leaves linearity.

Wanted to activate timer mechanism.

Peeked to try to see target item as it was placed in position. This happened more times than not.

Tachistoscope, Series II, Post-test: Closes eyes or lies down. Gives some response, but has been very difficult, 6/3/59.

Case Number 14

Sex: Female

Ethnic Group: Anglo

Childhood Diseases:
Measles, chicken pox
and mumps

Siblings: One brother
and one sister

Marital Status of Parents:
Divorced

Date of Birth: November 20, 1950

Prenatal and Natal History: Mongoloid,
precipitant delivery

Mother's Health History: Negative

Educational Level of Father:
Grades 7-12

Educational Level of Mother:
Grades 7-12

Psychological Evaluation: One evaluation, August, 1957

August, 1957

Chronological Age:	6-9
Mental Age:	2-6
Social Age:	3-8
Verbal Age:	2-0
Performance Age:	3-0
Intelligence Quotient:	36
Social Quotient:	54
Verbal Quotient:	30

Electroencephalography:

EEG Waking: Normal

EEG Sleeping: Normal, slow wave

Diagnosis: Mongoloid, neurologically normal

Ear, Nose, and Throat Examination: Two examinations, September, 1957 and May, 1959

Nose, positive, purvulent sinusitis present; tonsils hypertrophied and enlarged; tonsillectomy and adenoidectomy recommended, 9/57, 5/59

Right and left drums, abnormal, retracted, poor light reflex, opaque, 9/57, 5/59

Ophthalmological Examination: Two examinations, September, 1957 and May, 1959

Diagnosis, 9/57, 5/59, hyperopic (mild) astigmatism (mild), bilateral

Medical Examination: Head shape, brachycephalic. Probable congenital heart lesion

Height, Weight, Head Circumference, as compared with norms for American children from Watson and Lowrey (80):

	September, 1957	May, 1959
Percentile comparison, Height	Above 50th percentile	10th percentile
Percentile comparison, Weight	Below 90th percentile	Above 10th percentile
Weight Deviation for Age and Sex	Mean to +1 sigma	-1 sigma to mean
Height Deviation for Age and Sex	-1 sigma to mean	-1 sigma to mean

Head Circumference	-1.5 sigma to -2 sigma	-2 sigma to -1 sigma

Response to visual screening situations, as noted verbatim from anecdotal records of test record sheets:

Tachistoscope, Series II, Pretest: Some perseveration on M/C 1.

April 30, 1959 -- very difficult to attend on M/C's 1, 2, 3.

Constantly says stomach hurts.

This child used Kleenex to blow best of any child in sample.

Tachistoscope, Series II, Post-test: Reactions slower than on pretest.

Erratic on M/C 4, Keystone, Visual Acuity.

June 2, 1959, somewhat negative. Constantly says, "Shit." Child never the same on any two test periods.

Case Number 15

Sex: Female

Ethnic Group: Anglo

Childhood Diseases: None

Siblings: None

Marital Status of Parents: Married

Date of Birth: November 21, 1951

Prenatal and Natal History: Negative

Mother's Health History: Severe illness during pregnancy

Educational Level of Father: B. A.

Educational Level of Mother: Junior College

Psychological Evaluation: Two evaluations, July, 1957 and May, 1959

	July, 1957	May, 1959
Chronological Age:	5-8	7-5
Mental Age:	2-5	2-9
Social Age:	3-1	5-6
Verbal Age:	2-0	2-0
Performance Age:	2-10	2-10
Intelligence Quotient:	43	37
Social Quotient:	54	74
Verbal Quotient:	35	27

Electroencephalography:

EEG Waking: Normal

EEG Sleeping: Normal, slow wave

Diagnosis: Non-mongoloid, with neurologic defect, mild

Ear, Nose, and Throat Examination: Two examinations, September, 1957 and May, 1959

Right drum abnormal, moderately retracted; left drum abnormal, moderately retracted, poor light reflex, 9/57. Nose, positive, mucosa moderately edematous, 9/57. Tonsils, hypertrophied and enlarged, removal recommended, 9/57, 5/59. Right and left drums abnormal, moderately retracted, 5/59. Nose, positive, mucosa red and edematous, mucoid material present, 5/59

Ophthalmological Examination: Two examinations, September, 1957 and May, 1959

Diagnosis, 9/57, hyperopic (mild) astigmatism (mild), bilateral

Diagnosis, 9/57, hyperopic (mild) astigmatism (mild), right eye; emmetropia, left eye

Medical Examination: Eosinophils, high

Height, Weight, Head Circumference, as compared with norms for American children from Watson and Lowrey (80):

	September, 1957	May, 1959
Percentile comparison, Height	Unable to measure	Below 90th percentile
Percentile comparison, Weight	Unable to measure	Below 50th percentile
Weight Deviation for Age and Sex	Mean to +l sigma	Mean to +1 sigma

Height Deviation for Age and Sex	Unable to measure	Mean to +1 sigma
Head Circumference	Mean to +1 sigma	Mean to +1 sigma

Response to visual screening situations, as noted verbatim from anecdotal records of test record sheets:

Tachistoscope, Series II, Pretest: Erratic responses.

Child seems in a "fog." Is this child M. R. -- severe?

Mother did not want child brought over without a days' notice from teacher, for she wanted her "properly dressed."

Case Number 17

Sex: Female

Ethnic Group: Latin

Childhood Diseases: None

Siblings: None

Marital Status of Parents: Married

Date of Birth: June 23, 1950

Prenatal and Natal History: Precipitant delivery

Mother's Health History: Negative

Educational Level of Father:

Educational Level of Mother:

Psychological Evaluation: Two evaluations, September, 1957 and May, 1959

	September, 1957	May, 1959
Chronological Age:	7-3	8-10
Mental Age:	2-0	4-0
Social Age:	4-0	4-10
Verbal Age:	No speech	No speech
Performance Age:	2-6	4-1
Intelligence Quotient:	28	45
Social Quotient:	55	55
Verbal Quotient:	21	--

Electroencephalography:

EEG Waking: Normal

EEG Sleeping: Normal, slow wave

Diagnosis: Non-mongoloid, with neurologic defect, severe

Ear, Nose, and Throat Examination: Two examinations, September, 1957 and May, 1959

Tonsils, hypertrophied and enlarged, 9/57. Nasopharyngitis, 9/57

Nose, positive, 5/59. Tonsils, hypertrophied and enlarged, 5/59

Ophthalmological Examination: Two examinations, September, 1957 and May, 1959

Unable to refract, 9/57. Diagnosis, 5/59, hyperopic (mild) astigmatism (severe) bilateral

Medical Examination: Head shape -- hypertelorism. Probable congenital heart lesion

Height, Weight, Head Circumference, as compared with norms for American children from Watson and Lowrey (80):

	September, 1957	May, 1959
Percentile comparison, Height	Below 10th percentile	Below 10th percentile
Percentile comparison, Weight	Below 10th percentile	Below 10th percentile
Weight Deviation for Age and Sex	-2 sigma to -1 sigma	-2 sigma to -1 sigma
Height Deviation for Age and Sex	Greater than -3 sigma	Greater than -3 sigma
Head Circumference	Mean to + 1 sigma	Mean to + 1 sigma

Response to visual screening situations, as noted verbatim from anecdotal records of test record sheets:

Tachistoscope, Series II, Pretest:

Trouble on first test, AO Kg -- had trouble getting idea because of suspected hearing loss.

No random guessing -- when saw, noted; just would not guess.

February 10, 1959 -- does a lot of babbling.

______ got a pencil with which to point.

I keep feeling that there is cumulative effect on all these children.

Tachistoscope, Series II, Post-test:

______'s responses are very certain or she will not point. She needs firmness, then performs well.

Several responses are not the same as in others of the experimental group.

On Visual Achievement training card with divided rectangle, wouldn't respond until alternated with triangle.

Case Number 18

Sex: Female

Ethnic Group: Negro

Childhood Diseases: Measles, chicken pox, mumps

Siblings: Two brothers and three sisters

Marital Status of Parents: Married

Date of Birth: June 6, 1950

Prenatal and Natal History: Premature; forceps delivery

Mother's Health History: Negative

Educational Level of Father: Grades 7-12

Educational Level of Mother: Grades 7-12

Psychological Evaluation: Two evaluations, September, 1957 and May, 1959

	September, 1957	May, 1959
Chronological Age:	7-3	8-11
Mental Age:	2-3	3-4
Social Age:	3-4	4-4
Verbal Age:	2-0	3-5
Performance Age:	2-6	3-4
Intelligence Quotient:	31	37
Social Quotient:	46	49
Verbal Quotient:	28	38

Electroencephalography:

EEG Waking: Normal, slow wave

EEG Sleeping: Not taken

Diagnosis: Non-mongoloid with neurologic defect, moderate

Case Number 18 (continued)

Ear, Nose, and Throat Examinations: Two examinations, September, 1957 and May, 1959

Right and left drums, abnormal, retracted, poor light reflex, opaque, 9/57, 5/59. Tonsils hypertrophied and enlarged, tonsillectomy and adenoidectomy recommended, 9/57, 5/59

Ophthalmological Examination: Two examinations, September, 1957 and May, 1959

Muscles, left eye, positive, esotropis, hypertropia, 9/57, 5/59

Muscles, right eye, positive, hypertropia, 5/59

Diagnoses, 9/57, 5/59, hyperopic (mild) astigmatism (mild), right eye; hyperopic (mild) astigmatism (moderate) left eye

Medical Examination: Negative

Height, Weight, Head Circumference, as compared with norms for American children from Watson and Lowrey (80):

	September, 1957	May, 1959
Percentile comparison, Height	Below 10th percentile	Below 10th percentile
Percentile comparison, Weight	Below 10th percentile	Below 10th percentile
Weight Deviation for Age and Sex	-1.5 sigma to -2 sigma	-1.5 sigma to -2 sigma

Height Deviation for Age and Sex	-1.5 sigma to -2 sigma	Greater than -3 sigma

Head Circumference

Response to visual screening situations, as noted verbatim from anecdotal records of test record sheets:

Tachistoscope, Series II, Pretest: Response different from others. Seems to have a good amount of ability if controlled. More nearly able to verbalize response correctly. Counts 1-2-3 when flashes.

Pulls on my leg to get started. Touches legs and says, "HURRY!" Counts 1-2-3. Only child who can count flashes and knows that she gets three, at the end of three, she takes head out of eyepiece.

Tachistoscope, Series II, Post-test:

Tends to count flashes, 1-2-3.

M/C 6 too busy for _____. She responds better to "E" than most.

Left - down-up -- right doesn't seem to "throw."

Circle-ball, no recognition. Rubs eyes constantly. Only child who names objects consistently.

Left eye extremely strabismic today, 5/14/59.

Case Number 19

Sex: Female

Ethnic Group: Anglo

Childhood Diseases: Measles, convulsions

Siblings: Two brothers and two sisters

Marital Status of Parents: Unknown

Date of Birth: November 6, 1949

Prenatal and Natal History: Mongoloid

Mother's Health History: Negative

Educational Level of Father: Unknown

Educational Level of Mother: Grades 7-12

Psychological Evaluation: Two evaulations, August, 1957 and May, 1959

	August, 1957	May, 1959
Chronological Age:	7-10	9-6
Mental Age:	3-5	3-6
Social Age:	3-8	4-7
Verbal Age:	3-4.5	3-3
Performance Age:	3-5	3-9
Intelligence Quotient:	44	37
Social Quotient:	47	48
Verbal Quotient:	44	34

Electroencephalography:

EEG Waking: Moderate

EEG Sleeping: Moderate

Unilateral, focus abnormality, right. Tracings spike, slow wave, assymmetry, other abnormality. Record quality unsatisfactory

Diagnosis: Mongoloid, neurologic abnormality, mild

Ear, Nose, and Throat Examination: Two examinations, September, 1957 and May, 1959

Nose, positive, pus bilaterally (ethmoiditis), suppurative. Recommend tonsillectomy and adenoidectomy, 9/57. Right drum abnormal, poor light reflex, moderate retraction; left drum, abnormal, moderately retracted, 9/57. Nose, positive, pus bilaterally (ethmoiditis) suppurative, 5/59. Tonsils, hypertrophied, chronically infected, 5/59

Ophthalmological Examination: Two examinations, September, 1957 and May, 1959

Conjunctoblepharitis, chronic, 9/57, 5/59

Diagnosis, 9/57, hyperopic (mild) astigmatism (moderate), right eye; hyperopic (mild) astigmatism (severe), left eye. Glasses recommended

Diagnosis, 5/59, hyperopic (mild) astigmatism (severe), right eye; hyperopic (moderate) astigmatism (severe), left eye. Glasses recommended

Medical Examination: Head shape, brachycephalic

Height, Weight, Head Circumference, as compared with norms for American children from Watson and Lowrey (80):

	September, 1957	May, 1959
Percentile comparison, Height	Below 10th percentile	Below 10th percentile
Percentile comparison, Weight	Below 10th percentile	Below 10th percentile
Weight Deviation for Age and Sex	-1 sigma to mean	-2 sigma to -1 sigma
Height Deviation for Age and Sex	-2 sigma to -1 sigma	-1.5 sigma to -2 sigma
Head Circumference	-2 sigma to -1 sigma	-2 sigma to -1 sigma

Response to visual screening situations, as noted verbatim from anecdotal records of test record sheets:

Tachistoscope, Series II, Pretest: Object perservervation, Keystone. In responses the child may pick all four incorrect responses again and again but not hit correct until "on target."

Tachistoscope, Series II, Post-test: "E" verbal, others, points. Good orientation on "E's."

Case Number 20

Sex: Male

Date of Birth: August 6, 1947

Ethnic Group: Anglo

Prenatal and Natal History: Mongoloid

Childhood Diseases:

Measles

Mother's Health History: Negative

Educational Level of Father:

Siblings: One sister

Educational Level of Mother:

Marital Status of Parents:

Married

Psychological Evaluation: Two evaluations, August, 1957 and May, 1959

	August, 1957	May, 1959
Chronological Age:	10-0	11-9
Mental Age:	3-4	4-4
Social Age:	4-2	5-4
Verbal Age:	3-5	4-0
Performance Age:	3-2	4-8
Intelligence Quotient:	33	37
Social Quotient:	42	45
Verbal Quotient:	34	34

Electroencephalography:

EEG Waking: Moderate, unilateral focus abnormality

EEG Sleeping: Moderate, left. Tracings spike

Diagnosis: Mongoloid, neurologic abnormality, mild

Ear, Nose, and Throat Examination: Two examinations, September, 1957 and May, 1959

Nose, positive, mucosa, red and edematous, considerable pus present, 9/57, 5/59

Tonsils, hypertrophied, enlarged, removal recommended 9/57, 5/59

Left drums abnormal, poor light reflex, thickened; cerumen, right bilaterally, 9/57, 5/59

Ophthalmological Examination: Two examinations, September, 1957 and May, 1959

Chronic blepharitis, blepharo conjunctivitis, chronic, bilateral, 9/57. Eyelids very red, 5/59. Diagnosis, 9/57, hyperopic (mild) astigmatism. Diagnosis, 5/59, hyperopic (mild) astigmatism (mild), bilateral

Medical Examination: Head shape, brachycephalic. Probable congenital heart lesion

Height, Weight, Head Circumference, as compared with norms for American children from Watson and Lowrey (80):

	September, 1957	May, 1959
Percentile comparison, Height	Below 10th percentile	Below 10th percentile
Percentile comparison, Weight	Below 10th percentile	10th percentile

Weight Deviation for Age and Sex	-2 sigma to -1 sigma	-2 sigma to -1 sigma
Height Deviation for Age and Sex	-1.5 sigma to -2 sigma	-1.5 sigma to -2 sigma
Head Circumference	-.5 sigma to -2 sigma	-2 sigma to -1 sigma

Response to visual screening situations, as noted verbatim from anecdotal records of test record sheets:

Tachistoscope, Series II, Pretest: A quick, sure response on M/C 1, his first T-scope on 1/9/59.

Called ball a prickly pear on M/C 4.

State School children tend to right to left and up to down on response boards. We try never to have correct response in next sequence.

Tachistoscope, Series II, Post-test: After first training card, (M/C 4), said, "Oh, it's getting littler!"

Visual Achievement square/circle perseveration.

Case Number 21

Sex: Female

Date of Birth: May 16, 1948

Ethnic Group: Anglo

Prenatal and Natal History: Unknown

Childhood Diseases:

Mother's Health History: Unknown

Siblings: Two sisters

Educational Level of Father: Unknown

Marital Status of Parents: Unknown

Educational Level of Mother: Unknown

Psychological Evaluation: Two evluations, September, 1957 and May, 1959

	September, 1957	May, 1959
Chronological Age:	9-4	11-0
Mental Age:	3-5	4-5
Social Age:	5-4	5-2
Verbal Age:	3-1.5	4-0
Performance Age:	3-9	4-10
Intelligence Quotient:	37	40
Social Quotient:	57	47
Verbal Quotient:	34	36

Electroencephalography:

EEG Waking: Normal

EEG Sleeping: Normal, slow wave

Diagnosis: Non-mongoloid with neurologic defect, moderate

Ear, Nose, and Throat Examination: Two examinations, September, 1957 and May, 1959

Right drum, abnormal, scarred and retracted, poor light reflex; nose, positive; tonsils,hypertrophied, enlarged, 9/57. Right drum, abnormal, scarred and retracted; left drum, abnormal, scarred and retracted, 5/59

Ophthalmological Examination: Two examinations, September, 1957 and May, 1959

Diagnosis, 9/57, emmetropia, bilateral

Diagnosis, 5/59, hyperopic (mild) astigmatism (mild), right eye; emmetropia, left eye

Medical Examination: Negative

Height, Weight, Head Circumference, as compared with norms for American children from Watson and Lowrey (80):

	September, 1957	May, 1959
Percentile comparison, Height	Above 10th percentile	Below 10th percentile
Percentile comparsion, Weight	Below 50th percentile	Above 10th percentile
Weight Deviation for Age and Sex	-1 sigma to mean	-1 sigma to mean
Height Deviation for Age and Sex	-1 sigma to mean	-2 sigma to -1 sigma
Head Circumference	-1.5 sigma to -2 sigma	-2 sigma to -1 sigma

Response to visual screening situations, as noted verbatim from anecdotal records of test records:

Tachistoscope, Series II, Post-test: Tendency to linearity of responses.

Keystone: Object perseveration.

More unsettled than on pretests. Giddy on Keystone, puberty? 4/14/59, upset somewhat, substitute teacher.

Case Number 22

Sex: Male

Date of Birth: March 30, 1947

Ethnic Group: Anglo

Prenatal and Natal History: Premature, induced labor, not normal length

Childhood Diseases: Unknown

Mother's Health History: Severe illness, reported emotional trauma

Siblings: None

Educational Level of Father: Unknown

Marital Status of Parents: Divorced

Educational Level of Mother: Grades 7-12

Psychological Evaluation: Two evaluations, September, 1957 and May, 1959

	September, 1957	May, 1959
Chronological Age:	10-6	12-2
Mental Age:	3-3	3-3
Social Age:	4-4	5-2
Verbal Age:	2-9.5	2-8
Performance Age:	3-10	4-0
Intelligence Quotient:	31	27
Social Quotient:	41	42
Verbal Quotient:	27	22

Electroencephalography:

EEG Waking: Not taken

EEG Sleeping: Moderate, unilateral focus, abnormal, left. Tracings spike, slow wave, asymmetry

Diagnosis: Non-mongoloid with neurologic defect, moderate

Ear, Nose, and Throat Examination: Two examinations, September, 1957 and May, 1959

Right drum, abnormal, poor light reflex, thickened; left drum, abnormal, retracted, thickened, 9/57. Nose positive, mucosa congested, heavy mucopus present, 9/57. Nose, positive, pus bilaterally, ethmoiditis, suppurative, 5/59. Left ear drum, abnormal retracted, thickened; right ear drum, thickened, 5/59

Ophthalmological Examination: Two examinations, September, 1957 and May, 1959

Diagnosis, 9/57, hyperopic (mild) astigmatism (mild), bilateral

Diagnosis, 5/59, hyperopic (mild) astigmatism (mild), bilateral

Medical Examination: Hemoglobin, anemic

Height, Weight, Head Circumference, as compared with norms for American children from Watson and Lowrey (80):

	September, 1957	May, 1959
Percentile comparison, Height	Below 10th percentile	Below 10th percentile
Percentile comparison, Weight	Above 10th percentile	Below 10th percentile
Weight Deviation for Age and Sex	-1 sigma to mean	-2 sigma to -1 sigma

Height Deviation for Age and Sex	-1.5 sigma to -2 sigma	-1.5 sigma to -2 sigma
Head Circumference	Mean to +1 sigma	Mean to + 1 sigma

Response to visual screening situations, as noted verbatim from anecdotal records of test records:

Tachistoscope, Series II; Pretest: On M/C 1 always chose top, right hand; perseveration on response board. 4/1/59, strange behavior -- wanted to urinate, started down east stairs, wouldn't go -- back to lab, then repeated -- didn't want to get on elevator, finally did -- real scene, down on floor -- crying, on first floor. Had difficult time cooperating on AO Kg. Seemed to want to but just couldn't. Is this child MR or emotionally disturbed? 4/27/59, alone today (only child), so much freer. Keystone seemed frustrating all out of proportion; this is with all children, but especially _____.

Tachistoscope, Series II, Post-test: Unbelievable how much more settled since out of school. Out of school, 6/25/59. Possible perseveration on divided rectangle and triangle. Seems to decide response, look, then respond, M/C 4, Visual Achievement, Keystone. This child's ability to attend is like a light switch, "Off" then "On."

Case Number 23

Sex: Male

Ethnic Group: Anglo

Childhood Diseases: Unknown

Siblings: Two brothers and two sisters, mentally retarded

Marital Status of Parents: Married

Date of Birth: March 3, 1949

Prenatal and Natal History: Unknown

Mother's Health History: Unknown

Educational Level of Father: Unknown

Educational Level of Mother: Unknown

Psychological Evaluation: Two evaluations, October, 1957 and May, 1959

	October, 1957	May, 1959
Chronological Age:	8-7	10-3
Mental Age:	3-7	5-2
Social Age:	4-4	5-2
Verbal Age:	3-5.5	5-4
Performance Age:	3-10	5-0
Intelligence Quotient:	42	50
Social Quotient:	50	50
Verbal Quotient:	41	52

Electroencephalography:

EEG Waking: Normal, slow wave, movement artifacts

EEG Sleeping: Not taken

Diagnosis: Non-mongoloid with neurologic defect, mild

Ear, Nose, and Throat Examination: Two examinations, September, 1957 and May, 1959

Right drum, abnormal, poor light reflex; tonsils, hypertrophied, enlarged, 9/57. Right drum, abnormal, 5/59

Tonsillectomy and adenoidectomy, recommended, 9/57, 5/59

Ophthalmological Examination: Two examinations, September, 1957 and May, 1959

Diagnoses, 8/57, 5/59, hyperopic (mild) astigmatism (mild), bilateral

Medical Examination: Head shape, abnormal

Height, Weight, Head Circumference, as compared with norms for American children from Watson and Lowrey (80):

	September, 1957	May, 1959
Percentile comparison, Height	Above 10th percentile	Below 10th percentile
Percentile comparison, Weight	Below 90th percentile	90th percentile
Weight Deviation for Age and Sex	Mean to +1 sigma	+1 sigma to +2 sigma
Height Deviation for Age and Sex	-1 sigma to mean	-2 sigma to -1 sigma
Head Circumference	-1 sigma to mean	-2 sigma to -1 sigma

Response to visual screening situations, as noted verbatim from anecdotal records of test records:

Tachistoscope, Series II, Pretest: Looks at response board to see what he is going to be looking for. Commented on Keystone, Apple target, "Me like it." Recognized most targets by name. M/C 1, "Bus you ride in," "Car you ride in," "Fish you eat." Responses are sure, if sees, if not, reluctant to guess, but when he does guess, random, no perseveration.

Tachistoscope, Series II, Post-test: Some tendency to linearity on M/C 4 -- odd even with response board change. Visual Achievement: "Oh, I see a box!" or "Oh, I see _____!" ENTHUSIASM!!

Case Number 24

Sex: Male

Date of Birth: September 10, 1947

Ethnic Group: Anglo

Prenatal and Natal History: Precipitant delivery

Childhood Diseases: Measles, mumps

Mother's Health History: Unknown

Siblings:

Educational Level of Father: Unknown

Marital Status of Parents: Married

Educational Level of Mother: Unknown

Psychological Evaluation: Two evaluations, October, 1957 and May, 1959

	October, 1957	May, 1959
Chronological Age:	10-1	11-8
Mental Age:	3-8	4-4
Social Age:	--	5-5
Verbal Age:	3-7	4-6
Performance Age:	3-10	4-2
Intelligence Quotient:	36	37
Social Quotient:	--	46
Verbal Quotient:	36	39

Electroencephalography:

EEG Waking: Normal

EEG Sleeping: Moderate, unilateral, focus abnormal, right, tracings spike, slow wave, asymmetry

Diagnosis: Non-mongoloid with neurologic defect, moderate

Ear, Nose, and Throat Examinations: Two examinations, September, 1957 and May, 1959

Nose, positive, sinusitis, bilateral, granulated; tonsils, hypertrophied, enlarged, tonsillectomy and adenoidectomy recommended, 9/57, 5/59

Ophthalmological Examination: Two examinations, September, 1957 and May, 1959

Right eye muscles, positive, exotropia, alternating convergent squint; left eye muscles, positive, alternating convergent squint, 9/57, 5/59

Diagnoses, 9/57, 5/59, hyperopic (mild) astigmatism (moderate), bilateral. Glasses worn

Medical Examination: Head shape, abnormal

Height, Weight, Head Circumference, as compared with norms for American children from Watson and Lowrey (80):

	September, 1957	May, 1959
Percentile comparison, Height	Below 10th percentile	Above 10th percentile
Percentile comparison, Weight	Above 10th percentile	Below 10th percentile
Weight Deviation for Age and Sex	-2 sigma to -1 sigma	-2 sigma to -1 sigma

Height Deviation for Age and Sex	-1.5 sigma to -2 sigma	-1 sigma to mean
Head Circumference	-1 sigma to mean	Mean to + 1 sigma

Response to visual screening situations, as noted verbatim from anecdotal records of test records:

Tachistoscope, Series II, Pretest: Squirrel/rabbit confusion, Visual Achievement. Many reversals on Sjogren and E. May be that he stays in one position on response board (even though response boards changed) until he is sure. "A greyhound, but . . ." _____ seems to feel a compulsion to call by name regardless of how many times response board is changed. Response accepted only if first response, and only response.

Tachistoscope, Series II, Post-test: M/C 4, perseveration of position. M/C 2, position perseveration. M/C 6, fish, perseveration on 20/200. M/C 1, fish perseveration on 20/30 target. Possible perseveration AO Kg, trouble on boat. E, left, seems hardest. Very passive. Glasses have become badly scratched from being placed lenses down. So many things seem to come in with these children; linearity; perseveration, object and position; transfer inside to outside, etc.

Case Number 25

Sex: Female

Ethnic Group: Anglo

Childhood Diseases:

Siblings:

Marital Status of Parents:

Unknown

Date of Birth: May 11, 1948

Prenatal and Natal History:

Unknown

Mother's Health History: Unknown

Educational Level of Father: Unknown

Educational Level of Mother: Unknown

Psychological Evaluation: One evaluation, September, 1957

September, 1957

Chronological Age:	9-4
Mental Age:	3-5
Social Age:	5-0
Verbal Age:	43
Performance Age:	51
Intelligence Quotient:	37
Social Quotient:	40
Verbal Quotient:	34

Electroencephalography:

EEG Waking: Normal

EEG Sleeping: Normal, slow wave

Diagnosis: Non-mongoloid, no neurologic defect

Ear, Nose, and Throat Examination: One examination, September, 1957

Cerumen, caked, right ear, left ear, 9/57

Ophthalmological Examination: One examination, September, 1957

Diagnosis, 9/57, hyperopic (mild) astigmatism (mild), bilateral

Medical Examination: Negative

Height, Weight, Head Circumference, as compared with norms for American children from Watson and Lowrey (80):

	September, 1957	May, 1959
Percentile comparison, Height	50th percentile	Below 50th percentile
Percentile comparison, Weight	Above 50th percentile	Below 50th percentile
Weight Deviation for Age and Sex	- 1 sigma to mean	- 1 sigma to mean
Height Deviation for Age and Sex		
Head Circumference	- 1 sigma to mean	Mean to +1 sigma

Response to visual screening situations, as noted verbatim from anecdotal records of test records:

Tachistoscope, Series II, Pretest: Had trouble with fish on M/C 1. Failed six presentations at 1. 0 second, but then got boat at . 15 second. Visual Achievement, tendency to choose upper right item on response board. Linear response, very passive.

Case Number 26

Sex: Male

Date of Birth: March 15, 1946

Ethnic Group: Anglo

Prenatal and Natal History: Unknown

Childhood Diseases:

Measles

Mother's Health History: Unknown

Educational Level of Father:

Grades 7-12

Siblings:

Marital Status of Parents:

Divorced

Educational Level of Mother:

Grades 7-12

Psychological Evaluation: Two evaluations, August, 1957 and May, 1959

	August, 1957	May, 1959
Chronological Age:	11-5	13-2
Mental Age:	3-7	3-9
Social Age:	4-0	5-5
Verbal Age:	3-5	3-5
Performance Age:	3-9	4-0
Intelligence Quotient:	31	28
Social Quotient:	35	41
Verbal Quotient:	30	26

Electroencephalography:

EEG Waking:

EEG Sleeping:

Diagnosis:

Ear, Nose, and Throat Examination: Two examinations, September, 1957 and May, 1959

Right and left ear drums, abnormal, very retracted, milky; cerumen, right and left ears, 9/57, 5/59. Nose, positive, nasal mucosa, pale, considerable mucus, mucoid material present, mucosa congested, 9/57. Nose, positive, nasal mucosa, pale, considerable mucus present, pus in nostril, 5/59

Ophthalmological Examination: Two examinations, September, 1957 and May, 1959

Diagnoses, 9/57, 5/59, hyperopic (moderate) astigmatism (severe), bilateral. Glasses worn

Medical Examination: Head shape, brachycephalic

Height, Weight, Head Circumference, as compared with norms for American children from Watson and Lowrey (80):

	September, 1957	May, 1959
Percentile comparison, Height	Below 10th percentile	Below 10th percentile
Percentile comparison, Weight	Below 10th percentile	Below 10th percentile
Weight Deviation for Age and Sex	-2 sigma to -1 sigma	-2 sigma to -1 sigma
Height Deviation for Age and Sex	-1.5 sigma to -2 sigma	-1 sigma to mean

Head Circumference	Greater than -3 sigma	Greater than -3 sigma

Response to visual screening situations, as noted verbatim from anecdotal records of test records:

Tachistoscope, Series II, Pretest: Would respond linearily if response targets were not changed. The only child in the sample who demonstrated a rich phantasy life, "Trigger, Roy Rogers," etc., and carries through from State School to University of Texas, through test situation, and back to State School. Can be pulled away, but reverts.

Tachistoscope, Series II, Post-test: M/C 4, position perseveration, also AO Kg. Rich phantasy life.

Case Number 27

Sex: Female	**Date of Birth:** May 24, 1949
Ethnic Group: Anglo	**Prenatal and Natal History:** Mongoloid
Childhood Diseases:	**Mother's Health History:** Unknown
Measles and chicken pox	**Educational Level of Father:** Unknown
	Educational Level of Mother: Unknown

Siblings:

Marital Status of Parents:

Psychological Evaluation: Two evaluations, September, 1957 and May, 1959

	September, 1957	May, 1959
Chronological Age:	8-4	10-0
Mental Age:	2-5	2-6
Social Age:	4-4	4-11
Verbal Age:	2-0	2-4
Performance Age:	2-10	2-8
Intelligence Quotient:	29	25
Social Quotient:	52	49
Verbal Quotient:	24	23

Electroencephalography:

EEG Waking: Moderate

EEG Sleeping: Moderate, unilateral focus, abnormal, left, tracings spike, slow wave

Diagnosis: Non-mongoloid with neurologic defect, moderate

Ear, Nose, and Throat Examination: Two examinations, September, 1957 and May, 1959

Right drum, abnormal, thickened; cerumen, bilateral; accessory trag; left; atresia of ear canal, left; doubled uvula, 9/57

Right drum, abnormal, thickened; assessory trag; left ear; atresia of ear canal, left ear, 5/59. Nose, positive, considerable pus in nostril, 5/59

Ophthalmological Examination: Two examinations, September, 1957 and May, 1959

Conjunctivis, mild, 9/57. Diagnosis, 9/57, emmetropia, bilateral

Diagnosis, 5/59, hyperopic (mild) astigmatism (mild), bilateral

Medical Examination: Hemoglobin, anemic

Height, Weight, Head Circumference, as compared with norms for American children from Watson and Lowrey (80):

	September, 1957	May, 1959
Percentile comparison, Height	Below 10th percentile	Below 50th percentile
Percentile comparison, Weight	Below 10th percentile	Below 10th percentile
Weight Deviation for Age and Sex	-2 sigma to -1 sigma	-2 sigma to -1 sigma
Height Deviation for Age and Sex	-2 sigma to -1 sigma	-1 sigma to mean
Head Circumference	-1 sigma to mean	Mean to +1 sigma

Response to visual screening situations, as noted verbatim from anecdotal records of test records:

Tachistoscope, Series II, Pretest: AO (first T-scope) completely random on 20/200 up to .95 second, then first and quick choice. Perseverates even on difficult response boards. Gives name of object.

Tachistoscope, Series II, Post-test: M/C 4, position perseveration. M/C 3 perseveration of position. Note, right on 1.00 second, M/C 4.

APPENDIX C

APPENDIX C

Appendix C consists of data included in Table 5, Significance of Change Between the Pretest and Post-test Performances of the Massachusetts Vision Test, Tests 3, 4A, 4B, and on The Allied Muscle Balance Test. Those data are discussed specifically.

In the case of the Massachusetts Vision Test, Test 3, Distant Phoria, Vertical, n (the number of observations) = 9, and x (the smaller frequency) =1. For an n of 9, the probability associated with $x \leq 1$ was p= .02. Inasmuch as p was smaller than .05, the decision was to reject the null hypothesis. It was concluded that $p_1 > p_2$, that is, there was a difference in performance due to training and/or maturation. For the Massachusetts Vision Test, Test 4A, Distant Phoria, Horizontal, n (the number of observations) = 8, and x (the smaller frequency) = 1. For an n of 8, the probability associated with $x \leq 1$ was p= .035. The decision was to reject the null hypothesis in that p was smaller than .05. It was concluded that $p_1 \leq p_2$, that is, there was a difference due to training and/or maturation. For the Massachusetts Vision Test, Test 4B, Near Phoria, Horizontal, n (the number of observations) = 5, and x (the smaller frequency) = 0. For an n of 5, the probability associated with $x \leq 0$ was p = .031. In that p was smaller than .05, the decision was to reject the null hypothesis.

It was concluded that $p_1 \leq p_2$, that is, there was a difference in performance due to training and/or maturation. The null hypothesis for the Allied Muscle Balance Test, pretest and post-test, was that $p_1 = p_2 = 1/2$, that there was no difference between the probability that performance on the pretest (p_1) would be significantly different from the performance on the post-test (p_2). In the case of the Allied Muscle Balance Test, left eye, n (the number of observations) = 8, and x (the smaller frequency) = 2. For an n of 8, the probability associated with $x \leq 2$ was p = .145. Inasmuch as p was larger than .05, the decision was not to reject the null hypothesis, that there was no difference due to training and/or maturation. For the Allied Muscle Balance Test, right eye, n (the number of observations) = 7, and x (the smaller frequency) = 1. For an n of 7, the probability associated with $x \leq 1$ was p = .062. The decision was not to reject the null hypothesis, in that p was larger than .05. It was concluded that there was no significant difference due to training and/or maturation.

APPENDIX D

APPENDIX D

Appendix D consists of a comparison of referrals by screening tests with clinical ophthalmological findings of need for referral. Series I and Series II batteries were considered. Specific identification as to number and percentage for each category--correctly referred, needed care; over-referred; under-referred; correctly not referred--is presented.

The information included in Table 25 consists of a comparison of referral by the Plus Sphere, Test 2, Massachusetts Vision Test, Series I, pretest and post-test, compared with ophthalmological or clinical findings of correctly referred, needed ophthalmologic care, of correctly not referred, of over-referred, and of under-referred. Seventeen or 74% of the children screened were correctly referred. Of those seventeen, nine or 39% were correctly not referred and eight or 35% were correctly referred as needing ophthalmologic care. Six children, 26%, were incorrectly referred. There were four, 17% over-referred for care, and two, 9%, who were not referred but who needed ophthalmologic care.

The data included in Table 26 consists of a comparison of referral by Sjogren, Series I, pretest and post-test, with clinical ophthalmological findings of correctly referred, correctly not referred, over-referred, and under-referred.

TABLE 25

REFERRAL BY THE PLUS SPHERE, TEST 2, MASSACHUSETTS VISION TEST, SERIES I, PRETEST AND POST-TEST COMPARED WITH OPHTHALMOLOGICAL FINDINGS OF CORRECTLY REFERRED, CORRECTLY NOT REFERRED, OVER-REFERRED, AND UNDER-REFERRED

Children, by Case Number, as Referred by Plus Sphere, Series I	Children, by Case Number, as Referred by Ophthalmologist
301	301
402	402
203	203
Under-referral	306
Under-referral	207
308	308
209 (Over-referral)	
210	210
311	311
413 (Over-referral)	
217 (Over-referral)	
419	419
223 (Over-referral)	
224	224

TABLE 26

REFERRAL BY SJOGREN, SERIES I, PRETEST AND POST-TEST, COMPARED WITH OPHTHALMOLOGICAL FINDINGS OF CORRECTLY REFERRED, CORRECTLY NOT REFERRED, OVER-REFERRED, AND UNDER-REFERRED

Children, by Case Number, as Referred by Sjogren, Series I	Children, by Case Number, as Referred by Ophthalmologist
301	301
402	402
203	203
205 (Over-referral)	
306	306
207	207
308	308
209 (Over-referral)	
210	210
311	311
314 (Over-referral)	
215 (Over-referral)	
217 (Over-referral)	
218 (Over-referral)	
419	419
222 (Over-referral)	
224	224
326	326
227 (Over-referral)	

Sixteen children or 67% were correctly referred. Of those sixteen, five or 21% were correctly not referred and eleven or 46% were correctly referred, needing ophthalmologic care. Eight or 33% were over-referred. No children were under-referred.

Table 27 consists of a comparison of referral by the American Optical Illiterate E, pretest and post-test, compared with ophthalmological or clinical findings of correctly referred, correctly not referred, over-referred, and under-referred. Fourteen or 58% of the children were correctly referred by the Illiterate E. Of those fourteen, three, 13%, were correctly not referred, and eleven, 46%, were correctly referred as needing ophthalmologic care. Ten children were over-referred--that is 42% of the children screened were over-referred by the Illiterate E screening findings. No children were under-referred.

Table 28 consists of a comparison of referral by the American Optical Kindergarten Test, pretest and post-test, compared with clinical ophthalmological findings of correctly referred, correctly not referred, over-referred, and under-referred. Fourteen or 58% of the children were correctly referred by the American Optical Kindergarten Test. Three of those fourteen, 13%, were correctly not referred, and eleven, 46%, were correctly referred as needing ophthalmologic care. Ten children, 42%, were over-referred. No children were under-referred.

TABLE 27

REFERRAL BY AMERICAN OPTICAL ILLITERATE E, SERIES I, PRETEST AND POST-TEST, COMPARED WITH OPHTHALMOLOGICAL FINDINGS OF CORRECTLY REFERRED, CORRECTLY NOT REFERRED, OVER-REFERRED, AND UNDER-REFERRED

Children, by Case Number, as Referred by American Optical Illiterate E--Series I	Children, by Case Number, as Referred by Ophthalmologist
301	301
402	402
203	203
204 (Over-referral)	
205 (Over-referral)	
306	306
207	207
308	308
209 (Over-referral)	
210	210
311	311
314 (Over-referral)	
215 (Over-referral)	
217 (Over-referral)	
218 (Over-referral)	
419	419
420 (Over-referral)	
222 (Over-referral)	
224	224
326	326
227 (Over-referral)	

TABLE 28

REFERRAL BY AMERICAN OPTICAL KINDERGARTEN, SERIES I, PRETEST AND POST-TEST, COMPARED WITH OPHTHALMOLOGICAL FINDINGS OF CORRECTLY REFERRED, CORRECTLY NOT REFERRED, OVER-REFERRED, AND UNDER-REFERRED

Children, by Case Number, as Referred by American Optical Kindergarten--Series I	Children, by Case Number, as Referred by Ophthalmologist
301	301
402	402
203	203
204 (Over-referral)	
205 (Over-referral)	
306	306
207	207
308	308
209 (Over-referral)	
210	210
311	311
314 (Over-referral)	
215 (Over-referral)	
217 (Over-referral)	
218 (Over-referral)	
419	419
420 (Over-referral)	
222 (Over-referral)	
224	224
326	326
227 (Over-referral)	

The information included in Table 29 consists of a comparison of referral by the Maddox Rod, distant phoria, vertical Test 2 of the Massachusetts Vision Test, Series I, pretest and post-test, compared with ophthalmological findings of correctly referred, correctly not referred, over-referred, and under-referred. Sixteen, or 70% of the children screened, were correctly referred. Of those, eleven, 48%, were correctly not referred. Five children, 22% were correctly referred. Seven children, 30% were incorrectly referred, with six, 26%, being over-referred, and one, 4%, under-referred according to comparison with clinical judgment.

Data presented in Table 30 consist of referral by Maddox Rod, Test 4A, horizontal phoria, distant, Series I, pretest and post-test, compared with positive findings of muscle deviation by ophthalmologist on the basis of correctly referred, correctly not referred, over-referred, and under-referred. Fifteen children, 65% were correctly referred by Test 4A. Three, or 13% were correctly referred for ophthalmologic care, while twelve, or 52%, were correctly not referred. Eight, 35%, of the children screened were incorrectly referred. Five children, 22%, were over-referred, and three, or 13%, were under-referred when screening findings were compared with ophthalmological findings.

TABLE 29

REFERRAL BY MADDOX ROD TEST (PART 3, VERTICAL PHORIA, DISTANT), SERIES I PRETEST AND POST-TEST, COMPARED WITH POSITIVE FINDINGS OF MUSCLE DEVIATION BY OPHTHALMOLOGIST ON BASIS OF CORRECTLY REFERRED, CORRECTLY NOT REFERRED, OVER-REFERRED, AND UNDER-REFERRED

Children, by Case Number, as Referred by Maddox Rod, Vertical Phoria, Distant, Series I	Children, By Case Number, as Referred by Positive Ophthalmological Findings
402	402
203	203
205	205
207 (Over-referral)	
308 (Over-referral)	
209 (Over-referral)	
210	210
215 (Over-referral)	
218	218
419 (Over-referral)	
Under-referral	224
227 (Over-referral)	

TABLE 30

REFERRAL BY MADDOX ROD TEST, TEST 4A, HORIZONTAL PHORIA, DISTANT, SERIES I, PRETEST AND POST-TEST, COMPARED WITH POSITIVE FINDINGS OF MUSCLE DEVIATION BY OPHTHALMOLOGIST ON BASIS OF CORRECTLY REFERRED, CORRECTLY NOT REFERRED, OVER-REFERRED, AND UNDER-REFERRED

Children, by Case Number, as Referred by Maddox Rod, Horizontal Phoria, Distant, Series I	Children, by Case Number, as Referred by Positive Ophthalmological Findings
Under-referral	402
203	203
Under-referral	205
207 (Over-referral)	
209 (Over-referral)	
210	210
311 (Over-referral)	
215 (Over-referral)	
218	218
419 (Over-referral)	
Under-referral	224

The information contained in Table 31 consists of a comparison of referral by Maddox Rod, Test 4B, vertical phoria, distant, Series I, pretest and post-test, with positive findings of muscle deviation by the ophthalmologist. Comparison was on the basis of correctly referred, correctly not referred, over-referred, and under-referred. Seventeen children, 74%, were correctly referred; fourteen or 61% being correctly not referred, and three, or 13%, being under-referred.

The data presented in Table 32 consist of a comparison of referral by the Allied Muscle Balance Test, Series I, pretest and post-test, compared with positive findings of muscle deviation by ophthalmologist on the basis of correctly referred, correctly not referred, over-referred, and under-referred. Thirteen children, 57%, were correctly referred by the Allied Muscle Balance Test. Eight children, 35%, were correctly not referred, and five, 22%, were correctly referred as needing ophthalmologic care. Ten children, 43%, were incorrectly referred; nine, 39%, being over-referred, and one, 4%, being under-referred.

TABLE 31

REFERRAL BY MADDOX ROD TEST (PART 4B, HORIZONTAL PHORIA, NEAR), SERIES I PRETEST AND POST-TEST, COMPARED WITH POSITIVE FINDINGS OF MUSCLE DEVIATION BY OPHTHALMOLOGIST ON BASIS OF CORRECTLY REFERRED, CORRECTLY NOT REFERRED, OVER-REFERRED, AND UNDER-REFERRED

Children, by Case Number, as Referred by Maddox Rod, Horizontal Phoria, Near-- Series I	Children, by Case Number, as Referred by Positive Ophthalmological Findings
Under-referral	402
203	203
Under-referral	205
207 (Over-referral)	
308 (Over-referral)	
210	210
419 (Over-referral)	
218	218
Under-referral	224

TABLE 32

REFERRAL BY ALLIED MUSCLE BALANCE TEST, SERIES I PRETEST AND POST-TEST, COMPARED WITH POSITIVE FINDINGS OF MUSCLE DEVIATION BY OPHTHALMOLOGIST ON BASIS OF CORRECTLY REFERRED, CORRECTLY NOT REFERRED, OVER-REFERRED, AND UNDER-REFERRED

Children, by Case Number, as Referred by Allied Muscle Balance Test--Series I	Children, by Case Number, as Referred by Positive Ophthalmological Findings
301 (Over-referral)	
402	402
203	203
Under-referral	205
207 (Over-referral)	
308 (Over-referral)	
210	210
311 (Over-referral)	
314 (Over-referral)	
215 (Over-referral)	
217 (Over-referral)	
218	218
419 (Over-referral)	
420 (Over-referral)	
224	224

The data included in Table 33 consist of a comparison of the referrals by the Sjogren Hand, Series II, pretest and/or post-test, with ophthalmological findings of correctly referred, correctly not referred, over-referred, and under-referred. Seventeen children, 74%, were correctly referred by the Sjogren Hand screening tests. Ten children, 43%, were correctly not referred, and seven children, 30%, were correctly referred as needing ophthalmologic care. Six children, 26%, were incorrectly referred by the Sjogren Hand. Of those six children, four, 17%, were over-referred, and two, or 9%, were under-referred.

Table 34 consists of a comparison of the referrals by M/C 5, Series II, pretest and/or post-test, compared with ophthalmological findings of correctly referred, correctly not referred, over-referred, and under-referred. Fifteen children, 65%, were correctly referred by screening results of M/C 5. Seven children, 30%, were correctly not referred, and eight, 35%, were correctly referred as needing ophthalmologic care. Eight children, 35%, were incorrectly referred. Six children, 26.08%, were over-referred and two children, 9%, were under-referred.

TABLE 33

REFERRAL BY SJOGREN HAND, SERIES II, PRETEST AND/OR POST-TEST, COMPARED WITH OPHTHALMOLOGICAL FINDINGS OF CORRECTLY REFERRED, CORRECTLY NOT REFERRED, OVER-REFERRED, AND UNDER-REFERRED

Children, by Case Number, as Referred by Sjogren Hand--Series II	Children, by Case Number, as Referred by Ophthalmologist
301	301 (with glasses)
402	402
203	203
Under-referral	306
207	207
308	308
210	210
311	311
413 (Over-referral)	
314 (Over-referral)	
Under-referral	419
222 (Over-referral	
224	224
227 (Over-referral)	

TABLE 34

REFERRAL BY M/C 5, SERIES II, PRETEST AND/OR POST-TEST, COMPARED WITH OPHTHALMOLOGICAL FINDINGS OF CORRECTLY REFERRED, CORRECTLY NOT REFERRED, OVER-REFERRED AND UNDER-REFERRED

Children, by Case Number, as Referred by M/C 5--Series II	Children, by Case Number, as Referred by Ophthalmologist
301	301
402	402
203	203
205 (Over-referral)	
Under-referral	306
207	207
308	308
209 (Over-referral)	
210	210
311	311
413 (Over-referral)	
314 (Over-referral)	
Under-referral	419
222 (Over-referral)	
224	224
227 (Over-referral)	

The information included in Table 35 consists of a comparison of referral by M/C 3, Series II, pretest and/or post-test, compared with ophthalmological findings of correctly referred, correctly not referred, over-referred, and under-referred. Fifteen children, 65%, were correctly referred by screening results of M/C 3. Seven children, 30%, were correctly not referred and eight, 35%, were correctly referred as needing ophthalmologic attention. Eight children, 35%, were incorrectly referred. Six children, 26%, were over-referred and two children, 9%, were under-referred.

The data shown in Table 36 consist of a comparison of the referral by M/C 1, Series II, pretest and/or post-test, with ophthalmological findings of correctly referred, not referred, over-referred, and under-referred. Fifteen children, 65%, were correctly referred by the M/C 1 screening test. Eight children, 35%, were correctly not referred, and seven, 30%, were correctly referred as needing ophthalmologic care. Eight children, or 35%, were over-referred, and three or 13%, were under-referred.

TABLE 35

REFERRAL BY M/C 3, SERIES II, PRETEST AND/OR POST-TEST, COMPARED WITH OPHTHALMOLOGICAL FINDINGS OF CORRECTLY REFERRED, CORRECTLY NOT REFERRED, OVER-REFERRED AND UNDER-REFERRED

Children, by Case Number, as Referred by M/C 3--Series II	Children, by Case Number, as Referred by Ophthalmologist
301	301
Under-referral	402
203	203
205 (Over-referral)	
Under-referral	206
207	207
308	308
209 (Over-referral)	
210	210
311	311
314 (Over-referral)	
215 (Over-referral)	
419	419
221 (Over-referral)	
222 (Over-referral)	
224	224

TABLE 36

REFERRAL BY M/C 1, SERIES II, PRETEST AND/OR POST-TEST, COMPARED WITH OPHTHALMOLOGICAL FINDINGS OF CORRECTLY REFERRED, CORRECTLY NOT REFERRED, OVER-REFERRED AND UNDER-REFERRED

Children, by Case Number, as Referred by M/C 1--Series II	Children, by Case Number, as Referred by Ophthalmologist
301	301
402	402
203	203
205 (Over-referral)	
Under-referral	306
207	207
308	308
Under-referral	210
311	311
413 (Over-referral)	
314 (Over-referral)	
Under-referral	419
222 (Over-referral)	
224	224
227 (Over-referral)	

The data presented in Table 37 consist of a comparison of the referrals by the Snellen E, Series II, pretest and/or post-test, with ophthalmological findings of correctly referred, correctly not referred, over-referred, and under-referred. Fifteen children, 65%, were correctly referred by the screening results of the Snellen E. Seven children, 30%, were correctly not referred, and eight children, 35%, were correctly referred as needing ophthalmologic care. Eight children, 35%, were incorrectly referred. Six children, 26%, were over-referred, and two children, 9%, were under-referred.

The data included in Table 38 consist of a comparison of the referrals by M/C 4, Series II, pretest and/or post-test, with ophthalmological findings of correctly referred, correctly not referred, over-referred, and under-referred. Fourteen children, 61%, were correctly referred by the screening results of M/C 4. Six children, 26%, were correctly not referred, and eight children, 35%, were correctly referred as needing ophthalmologic care. Nine children, 39%, were incorrectly referred. Seven children, 30%, were over-referred, and two children, 9%, were under-referred.

TABLE 37

REFERRAL BY SNELLEN E, SERIES II, PRETEST AND/OR POST-TEST, COMPARED WITH OPHTHALMOLOGICAL FINDINGS OF CORRECTLY REFERRED, CORRECTLY NOT REFERRED, OVER-REFERRED, AND UNDER-REFERRED

Children, by Case Number, as Referred by Snellen E--Series II	Children, by Case Number, as Referred by Ophthalmologist
301	301
402	402
203	203
205 (Over-referral)	
Under-referral	306
207	207
308	308
210	210
311	311
413 (Over-referral)	
314 (Over-referral)	
Under-referral	419
221 (Over-referral)	
222 (Over-referral)	
224	224
227 (Over-referral)	

TABLE 38

REFERRAL BY M/C 4, SERIES II, PRETEST AND/OR POST-TEST, COMPARED WITH OPHTHALMOLOGICAL FINDINGS OF CORRECTLY REFERRED, CORRECTLY NOT REFERRED, OVER-REFERRED AND UNDER-REFERRED

Children, by Case Number, as Referred by M/C 4--Series II	Children, by Case Number, as Referred by Ophthalmologist
301	301
402	402
203	203
306	306
207	207
308	308
209 (Over-referral)	
Under-referral)	210
311	311
413 (Over-referral)	
314 (Over-referral)	
215 (Over-referral)	
Under-referral	419
221 (Over-referral)	
222 (Over-referral)	
224	224
227 (Over-referral)	

The data shown in Table 39 consist of a comparison of the referrals by M/C 2, Series II, pretest and/or post-test, with ophthalmological findings of correctly referred, correctly not referred, over-referred, and under-referred. Fourteen children, 61%, were correctly referred by the screening results of M/C 2. Six children, or 26%, were correctly not referred, and eight children, or 35%, were correctly referred as needing ophthalmologic care. Nine children, 39%, were incorrectly referred. Seven children, or 30%, were over-referred, and two children, 9%, were under-referred.

The data included in Table 40 consist of a comparison of the referrals by the Kindergarten Chart, Series II, pretest and/or post-test, with ophthalmological findings of correctly referred, correctly not referred, over-referred, and under-referred. Fourteen children, 61%, were correctly referred by the screening results of the Kindergarten Chart. Five children, or 22%, were correctly not referred, and nine children, or 39%, were correctly referred as needing ophthalmologic care. Nine children, 39%, were incorrectly referred. Eight children, or 35%, were over-referred, and one child, 4%, was under-referred.

TABLE 39

REFERRAL BY M/C 2, SERIES II, PRETEST AND/OR POST-TEST, COMPARED WITH OPHTHALMOLOGICAL FINDINGS OF CORRECTLY REFERRED, CORRECTLY NOT REFERRED, OVER-REFERRED, AND UNDER-REFERRED

Children, by Case Number, as Referred by M/C 2, Series II	Children, by Case Number, as Referred by Ophthalmologist
301	301
402	402
203	203
205 (Over-referral)	
Under-referral	206
207	207
308	308
209 (Over-referral)	
210	210
311	311
413 (Over-referral)	
314 (Over-referral)	
Under-referral	419
222 (Over-referral)	
223 (Over-referral)	
224	224
227 (Over-referral)	

TABLE 40

REFERRAL BY KINDERGARTEN CHART, SERIES II, PRETEST AND/OR POST-TEST, COMPARED WITH OPHTHALMOLOGICAL FINDINGS OF CORRECTLY REFERRED, CORRECTLY NOT REFERRED, OVER-REFERRED, AND UNDER-REFERRED

Children, by Case Number, as Referred by Kindergarten Chart--Series II	Children, by Case Number, as Referred by Ophthalmologist
301	301
402	402
203	203
204 (Over-referral)	
205 (Over-referral)	
306	306
207	207
308	308
209 (Over-referral)	
210	210
311	311
413 (Over-referral)	
314 (Over-referral)	
215 (Over-referral)	
217 (Over-referral)	
Under-referral	419
224	224
227 (Over-referral)	

The data presented in Table 41 consist of a comparison of the referrals by Keystone Preschool, Series II, pretest and/or post-test, with ophthalmological findings of correctly referred, correctly not referred, over-referred, and under-referred. Thirteen children, 57%, were correctly referred by the screening results of the Keystone Preschool. Six children, 26%, were correctly not referred, and seven, 30%, were correctly referred as needing ophthalmologic care. Ten children, 43%, were incorrectly referred. Seven children, 30%, were over-referred, and three children, 13%, were under-referred.

The data shown in Table 42 consist of a comparison of the referrals by Visual Achievement, Series II, pretest and/or post-test, with ophthalmological findings of correctly referred, correctly not referred, over-referred, and under-referred. Eleven children, or 48%, were correctly referred by the screening results of the Visual Achievement. Five children, 22%, were correctly not referred, and six, or 26%, were correctly referred as needing ophthalmologic care. Twelve children, 52%, were incorrectly referred. Eight children, or 35%, were over-referred, and four children, 18%, were under-referred.

TABLE 41

REFERRAL BY KEYSTONE PRESCHOOL, SERIES II, PRETEST AND/OR POST-TEST, COMPARED WITH OPHTHALMOLOGICAL FINDINGS OF CORRECTLY REFERRED, CORRECTLY NOT REFERRED, OVER-REFERRED, AND UNDER-REFERRED

Children, by Case Number, as Referred by Keystone Preschool--Series II	Children, by Case Number, as Referred by Ophthalmologist
301	301
402	402
203	203
205 (Over-referral)	
Under-referral	306
Under-referral	207
308	308
209 (Over-referral)	
Under-referral	210
311	311
413 (Over-referral)	
314 (Over-referral)	
215 (Over-referral)	
419	419
221 (Over-referral)	
222 (Over-referral)	
224	224

TABLE 42

REFERRAL BY VISUAL ACHIEVEMENT, SERIES II, PRETEST AND/OR POST-TEST, COMPARED WITH OPHTHALMOLOGICAL FINDINGS OF CORRECTLY REFERRED, CORRECTLY NOT REFERRED, OVER-REFERRED, AND UNDER-REFERRED

Children, by Case Number, as Referred by Visual Achievement--Series II	Children, by Case Number, as Referred by Ophthalmologist
Under-referral	301 (with glasses)
402	402
203	203
204 (Over-referral)	
205 (Over-referral)	
Under-referral	306
207	207
308	308
Under-referral	210
311	311
413 (Over-referral)	
314 (Over-referral)	
217 (Over-referral)	
Under-referral	419
221 (Over-referral)	
222 (Over-referral)	
224	224
227 (Over-referral)	